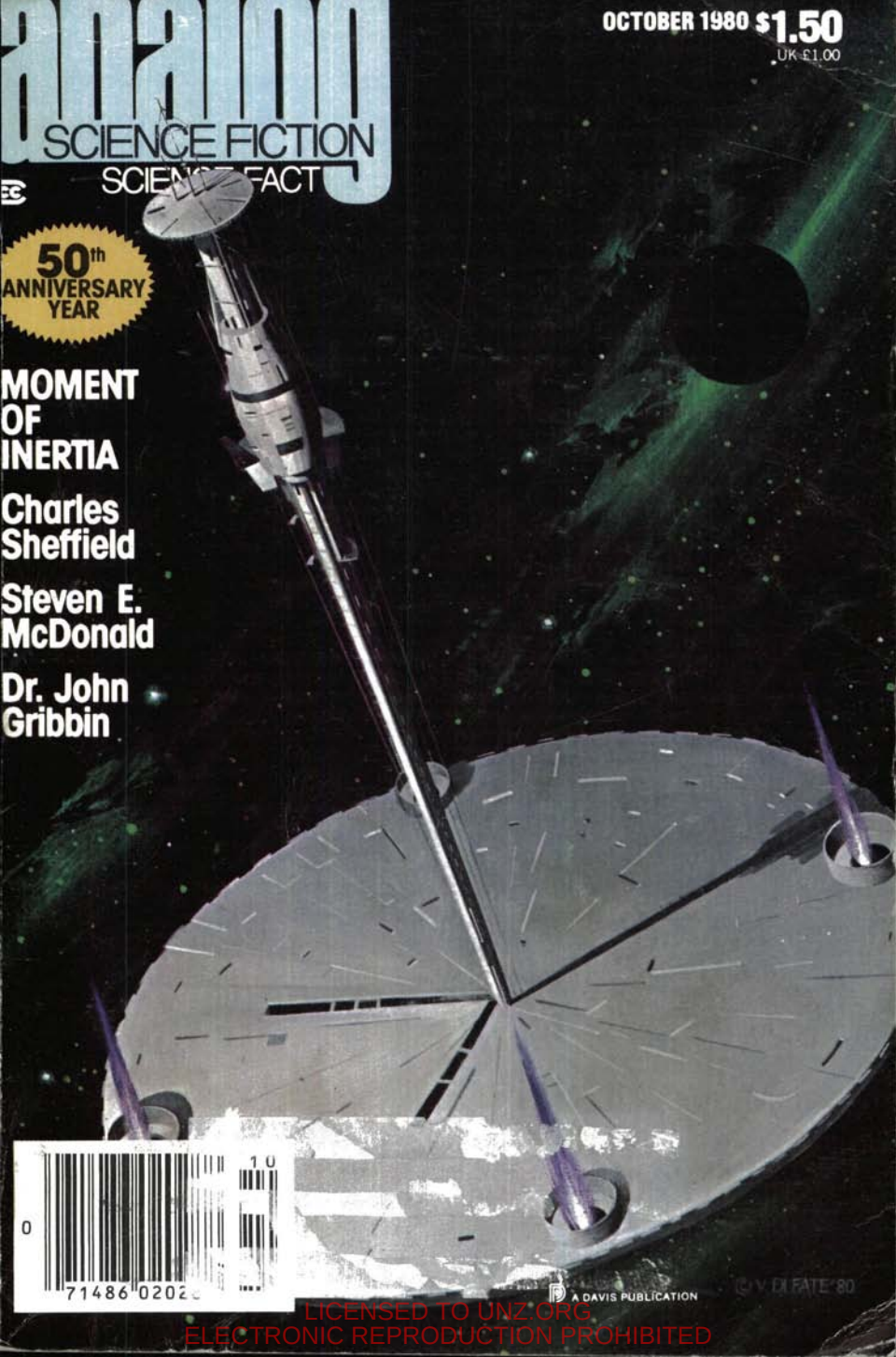

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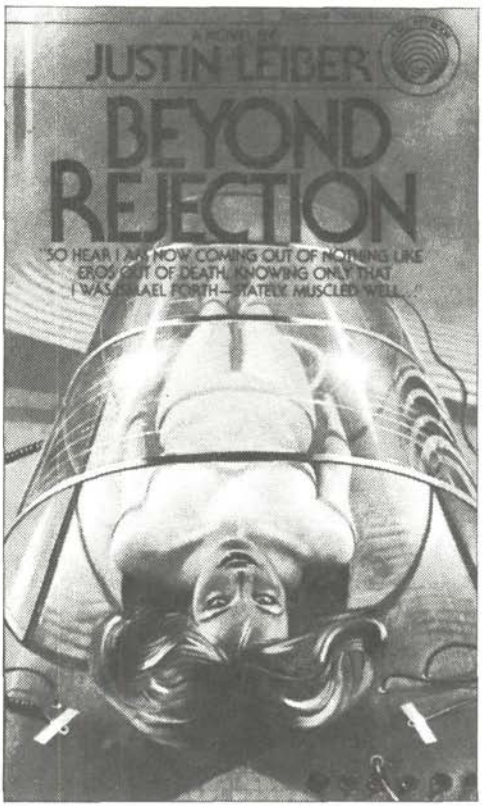

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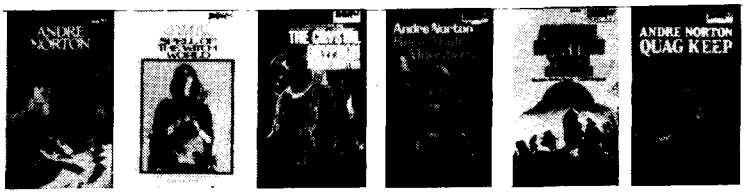

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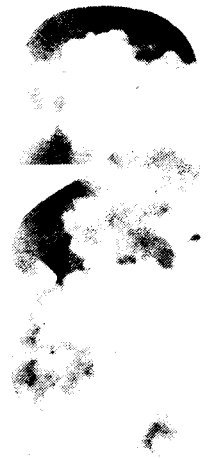
Next Issue on Sale
October 9, 1980
$10.00 per year in U.S.A.
$1.50 per copy

Cover by Vincent DiFate

Vol. C No. 10
OCTOBER 1980



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Analog Science Fiction/Science Fact Magazine published monthly by Davis Publications, Inc., at $1.50 a copy. Annual subscription $10.00 in the U.S.A. and possessions, $12.00 elsewhere, payable in advance. First copy of new subscription will be mailed within eight weeks of receipt of order. When reporting change of address allow 6 to 8 weeks and give new address as well as the old address as it appears on the last label. Application to mail at controlled circulation rates is pending at Dallas, PA. 18612. Copyright © 1980 by Davis Publications, Inc., all rights reserved. Reproduction secured under the Universal Copyright Convention. Reproduction or use of editorial or pictorial content in any manner without express permission is prohibited. All stories in this magazine are fiction. No actual persons are designated by name or character. Any similarity is coincidental. Printed in U.S.A. All submission must be accompanied by stamped self-addressed envelope; the Publisher assumes no responsibility for unsolicited manuscripts or artwork.

Joel Davis, President & Publisher; **Victor C. Stabile**, Vice Pres. & Treas.; **Leonard F. Pinto**, Vice Pres. & General Manager; **Carole Dolph Gross**, Vice Pres., Marketing—Editorial

Postmaster: SEND FORM 3579 to ANALOG SCIENCE FICTION/SCIENCE FACT, BOX 2670, GREENWICH CT 06836.

Editorial and Advertising
Analog
Science Fiction/Science Fact
380 Lexington Avenue
New York, NY 10017

Subscriptions:
Analog
Science Fiction/Science Fact
Box 2670
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ISNN 0161-2328

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STANLEY SCHMIDT

ADVICE FOR "CRACKPOTS"

EDITORIAL

Since I do not want to get off on the wrong foot by antagonizing the very "crackpots" to whom these remarks are respectfully dedicated, I must begin by defining my terms.

A "crackpot"—in quotes—is an individual who is considered, as the dictionary says, "a harmless lunatic." A person, in other words, who expounds ideas or claims abilities which the generally acknowledged authorities agree are nonsense.

A *crackpot*—not in quotes—is an individual whose ideas or claims really *are* nonsense, in the sense that they contradict not the accepted wisdom, but the actual behavior of the universe.

Please note carefully that the two terms, defined thus, are quite

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distinct. A person may be either, or both, or neither.

The terms would be equivalent if the opinions of the generally acknowledged authorities were always exact descriptions of the real universe—but, of course, they aren't. They are approximations—sometimes very close, sometimes way off the beam.

And they change.

It's easy to come up with a list of people who were, at least to some extent, "crackpots" in their own times. Nicolas Copernicus and Galileo Galilei: the Earth goes around the sun. Christopher Columbus: the Earth is round. Charles Darwin: species, including man, evolve from (and to) other species. Louis Leakey: man originated in Africa, not Asia. Albert Einstein: the speed of light is constant, but space and time aren't. Alfred Wegener: continents drift across the Earth's surface.

Not all of these fit the definition equally well. Some were not considered harmless; some had little trouble getting their work published, though it was controversial afterward. The actual difficulties they faced were seldom very close to the ones associated with them in the folklore, but each of them proposed ideas which were, at the time, at least mildly disconcerting to at least some people.

Not one of them is still considered (by most) a crackpot. Their ideas, once more or less widely scoffed at, have become part of the accepted wisdom—which has the interesting consequence that anybody who significantly disagrees with those ideas now *is* a "crackpot."

As such, somebody who challenges the theory of relativity or continental drift will, quite likely, have a harder than average time getting his ideas before the public. It may seem to him that there is a genuine conspiracy, with the world united to suppress his ideas, and *nobody* willing to give them a fair shake. In general, this is an exaggerated view. Articles questioning generally accepted theories do get published, even in the more straight-laced professional journals. (An article questioning some detail of relativity or continental drift is, of course, more likely to be published than one questioning the approximate sphericity of our planet. This may have something to do with the age of the theories—but it may also have something to do with the amount and quality of supporting evidence which has been collected.)

Still, it must be admitted that a great many "crackpot" theories do *not* get published, and it is no doubt true that in many cases they are rejected at least partly because of prejudice. The disturbing possibility does exist that among those rejected theories are some which are genuinely better than their currently respectable counterparts, and that the failure to publish and pursue them blocks real and desirable progress—in some cases, perhaps, permanently. After all, the names above are all associated with what most of us now consider monumental advances, yet those advances were not greeted with chorused enthusiasm as soon as they appeared. . . .

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For such reasons—and because really fundamental breakthroughs, by definition, *cannot* be deduced logically from previously existing theories—some of us think it important that some outlets exist where highly unorthodox ideas can be aired. Analog has long been such an outlet, having carried extensive discussions of such subjects as dianetics, psionics, Dean drives, and neurophones. Some of what we've published has not held up. That's fine: we've learned something. In many other cases, important questions remain open. That's fine, too—provided somebody keeps trying to answer them.

But neither Analog nor any finite number of publications can possibly accommodate *all* the "crackpot" ideas which may contain something worth investigating. There simply isn't room. Therefore most of the unorthodox proposals *have* to be rejected.

And the blunt fact is that many "crackpots" really are *crackpots*. I don't mean to call anybody names, but a great many unorthodox papers which cross my desk really do contain blatant nonsense—ideas which are seriously at odds not just with fashionable theory, but with well-established *observation* of what really happens. Above I offered a brief list of "crackpots" who were eventually welcomed into the fold; I could make a much longer list of others who weren't, but it would be harder because most of them have been forgotten—in most cases, I suspect, deservedly so.

The real crackpots are the ones who give "crackpots" a bad name. And they make it harder for those with good, important ideas to be heard, in a still more basic way. If those ideas are to receive any support, encouragement, or constructive criticism, they must be shown to other people—research scientists, teachers, editors, etc.

And those people have only finite time to devote to such things.

Thus any serious "crackpot" must understand, at a very deep level, these two basic facts. (1) Anyone you send your work to will have seen a lot more genuine crackpottery than good original ideas among the unsolicited unorthodoxy which has crossed his desk, and this experience will have conditioned him to approach such things warily. (2) On the average, he will not be able to spend much time on such offerings. He may gladly do so if he sees immediate evidence that it may be worthwhile, but not otherwise.

I've had plenty of such things sent my way, both as a physics professor and as Analog editor. Among them were a few intriguing ideas—and a lot of gibberish: stuff which simply ignored a great body of experimental observation and added none of its own. Many were very long and not clearly written; in a few extreme cases I read several pages carefully and still had not the remotest idea of what the subject was. Some were single-spaced or even handwritten, which admittedly has nothing to do with the validity of the content, but it certainly does have something to do with its accessibility. An appreciable number were accompanied by boasting or semi-threatening letters: "Put your money where your mouth is, sir. If you have any guts at all, you'll print this—but I realize it *will* take courage." (Well, that may be—though in some cases

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"gall" might be a better word. It would also take *space*, and I only have room for about a dozen fact articles a year. If you want yours to be one of them, *you* have to convince *me* that it deserves to be.)

Sometimes I'm not the first to receive these offerings. They arrive with letters plaintively recounting how others have refused even to look at them—plus, ironically, sheafs of correspondence showing clearly that others have, in fact, given them a great deal of time (which they must afterward have regretted wasting).

I look at *all* of these things. I try to see whether each really does have something new and important to say. I am *most* interested in new ideas, and there are few things more exciting than finding one. But experience has taught me that the probability of this time being productively spent is disappointingly low. Too often, when I have spent a lot of time on something like this, deciphering poor English and worse mathematics, I have found that the author simply did not understand the field. People try desperately to disprove relativity with no understanding of what relativity really says. Elementary mathematical errors totally invalidate conclusions. This sort of thing has happened so often that I now have a pretty good feel for when I'm dealing with this kind of material. This doesn't mean that I'll never dismiss a piece out of hand, but it does mean that the time I'll spend on it is limited. I have other work to do, and, like it or not, I must assign priorities.

The situation of others, in industry or academia, is not so different. So what can you do if you have a good but unorthodox idea? I can guarantee nothing except that you *will* meet prejudice in some circles, no matter what you do. You will meet other resistance which is *not* prejudice, but genuine professional standards of a kind absolutely essential to science. But you will also find listeners, if you look hard enough and well enough—and your search may well have a better chance if you understand the following suggestions and keep them constantly in mind.

1. *Do your homework.* Learn what's been done (and this requires that you know how to do a literature search). If you're questioning an old theory, be sure you understand— thoroughly—what that theory says. Find out also what observational evidence has been accumulated for and against it. A theory such as relativity does not gain wide acceptance because of somebody's whim, but because it fits a large body of experimental data better than its predecessors. Basic breakthroughs will not be made by people who are sure the accepted knowledge is the last word, but they will not be made by people who are ignorant of what's been done, either. A healthy disrespect for authority is a fine and useful thing. A casual disregard of observed reality is not.
2. *Don't try to intimidate your reader.* I'm not sure what people hope to accomplish with those letters. Do they want their work judged solely on its merits, or not? The letters unwittingly suggest otherwise.
3. *Try to see your work from your reader's viewpoint—and understand*

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that the time he can spend on it is limited. When I, or somebody else, receive an exposition of your experiments or ideas, we naturally hope it will contain something valid and earth-shaking—but, statistically, we know that's unlikely. I am not likely to read a hundred single-spaced pages of abstruse prose, searching intently for a gem, if I don't find some indication quite early that this has a reasonable chance of being gem territory. This means two things for you as you write:

(a) Somewhere in your very first page you need to spell out—*in very clear, easy-to-read English*—exactly what is the essence of what you've done—and why it is important. Professional journals usually require an abstract in addition to the main text for this purpose. That never hurts, but in any case you should bear in mind that if I read two pages of your paper and still can't figure out exactly what its point is, I'm not going to be very anxious to spend much time reading the rest. On the other hand, if I can see immediately that it does claim to make an important point, I'm going to be *very* interested in reading on to see whether you have solid support for that point. And if it continues to seem that you do, I will spend as much time as necessary to make sure of that.

(b) You need to make the *entire* text as concise, clear, and easy to follow as possible, aided where appropriate by clear and well labeled diagrams. Then if you've succeeded in point (a), so I want to read on, I'll retain that interest to the end—and be able to get through it all in a reasonable time.

If these sound suspiciously similar to recommendations you've heard for *any* kind of writing—that's no coincidence.

4. *Don't expect people to publish or research your idea unless* you *convince* them *it's to* their *benefit.* I, for instance, am in the business of producing a magazine for sale and enjoyment, and my publisher would not take kindly to my devoting many of its pages to material which sent my readers elsewhere feeling that their intelligence had been insulted. If you have an idea for a space drive, it's *your* responsibility to build a working model for demonstration —unless you can give a theoretical justification so convincing that some company will consider it a good investment to do so themselves. Remember, it's *their* money you're asking them to spend.

5 *Don't waste time on indignant follow-up letters if somebody who sees your work does not respond enthusiastically—or at all.* Okay: he didn't

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see the merit in your masterpiece. That may mean that there isn't any, or that he's prejudiced and closed-minded (in which case he isn't going to be much help to you anyway), or that you failed to present your case well enough. It's always worthwhile to see if you can make significant improvements in the light of the suggestions above. If you can, it may be worthwhile to offer somebody a second look. Otherwise, just keep searching. Another type of follow-up letter may be in order, incidentally, if you're lucky enough to find two people interested in your work. If one of them manages to establish something new about it, by way of either support or disproof, it's only courteous to let the other know.

It should be obvious that I *am* interested in seeing good, new, offbeat ideas. If I weren't, I wouldn't have bothered to write this. When this advice is followed, the interchange of ideas can be potentially important or, at the very least, a lot of fun.

For example: a gentleman in Greece long ago proved to most mathematicians' satisfaction that angle trisection—the purely geometrical division of an angle into three equal parts using only a compass and straightedge—can't be done. Much more recently, a gentleman in Michigan thought he had done it. He had a construction worked out, as well as a working model of a device for carrying out a streamlined version of it mechanically. He did not have a rigorous proof that the construction was really what he thought it was, but he did have a detailed description of the construction which he was sending around in hopes of getting help in proving that it was (or wasn't) the construction so long thought impossible. He met the usual quota of glib rejections, but I was interested. He had a clearly defined problem and a description of his work which I could follow. It took much longer than I usually spend on such things, but it seemed worth continuing as long as I could not find a step that was obviously invalid—which was all the way to the end. I could see a way to determine rigorously whether or not the construction was exact, but I could also see that carrying it out was going to involve complicated and time-consuming trigonometry.

Meanwhile, someone else—an academic mathematician, as I recall—also got interested and carried out a detailed analysis before I found time. He found that it was not a rigorous construction, but it *was* an excellent engineering approximation, never off by more than a fraction of a degree. I really appreciated the inventor's taking time to write and let me know of that result—including sending me a copy of the professor's analysis before I had spent a lot of time duplicating it. We have had a highly enjoyable correspondence since then, and I look forward to more of such in the future.

But, in all honesty, I do *not* look forward to impenetrable tomes heralded by annoyingly defensive letters and expounding ideas which are either unintelligible or clearly and demonstrably untenable. By all means send me your ideas; I want to see them—but, please, only *after* you've assimilated the advice above. ■

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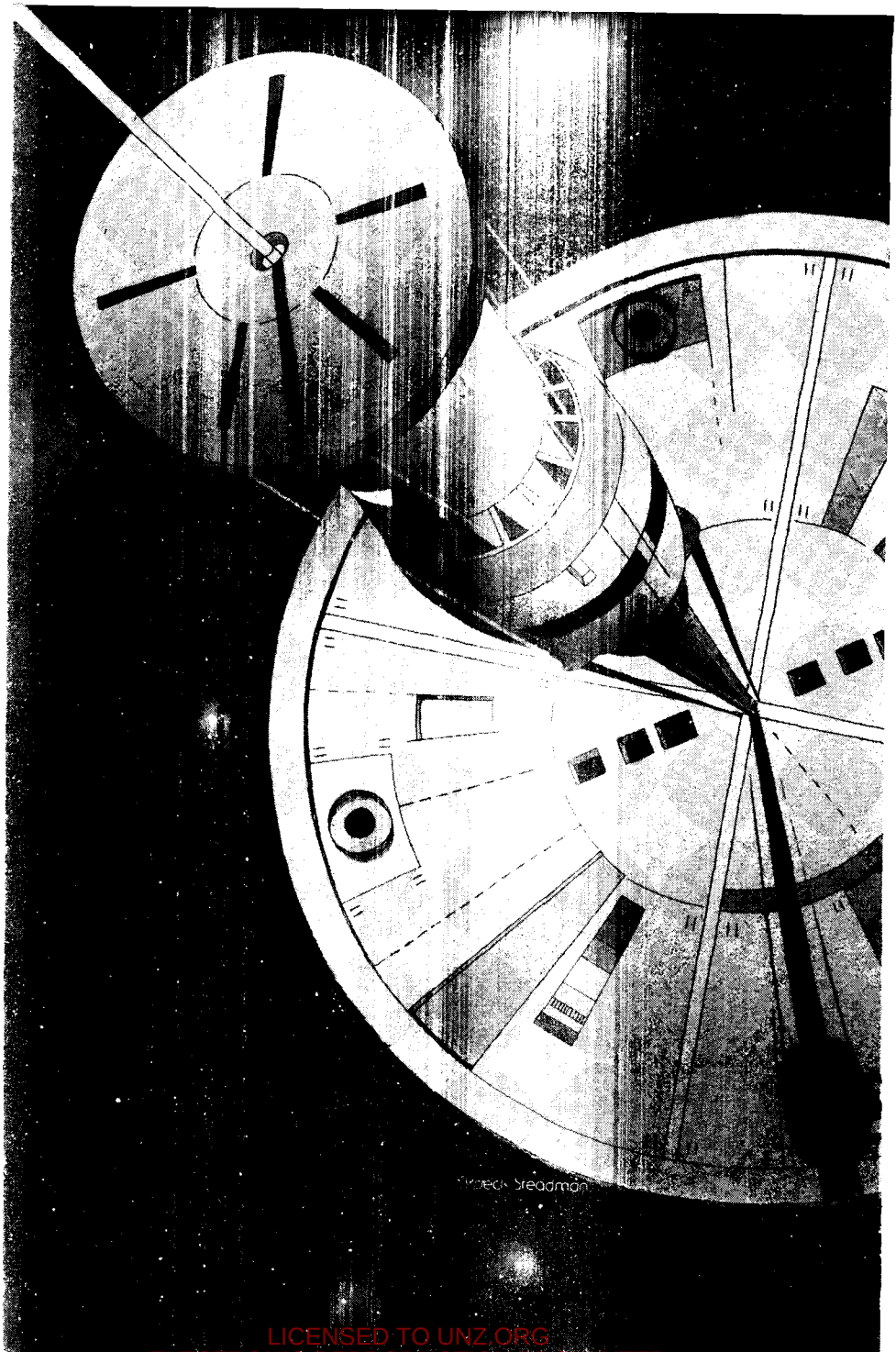

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"Now," said the interviewer, "tell us just what led you to the ideas for the inertia-less drive."

She was young and vulnerable-looking, and I think that was what saved her from a hot reply. As it was, McAndrew just shook his head and said quietly—but still with feeling—"Not the *inertia-less* drive. There's no such thing. It's a *balanced* drive."

She looked confused. "But it lets you accelerate at more than fifty gees, doesn't it? By making you so you don't feel any acceleration at all. Doesn't that mean you must have no inertia?"

McAndrew was shaking his head again. He looked pained and resigned. I suppose that he had to go through this explanation twice a day, every day of his life, with somebody.

I leaned forward and lowered the sound on the video unit. I had heard the story too often, and my sympathies were all with him. We had direct evidence that the McAndrew drive was anything but inertia-less. I doubt if he'll ever get that message across to the average person, even though he's most people's idea of the "great scientist," the ultimate professor.

I was there at the beginning of the whole thing. In fact, according to McAndrew I *was* the beginning. We had been winding our way back from the Titan Colony, travelling light as we usually did on the in-bound leg. We had only four sections in the *Assembly*, and only two of them carried power kernels and drive units, so I guess we massed about three billion tons for ship and cargo.

Halfway in, just after turnover point, we got an incoming request for medical help from the mining colony on Horus. I passed the word on to Luna Station, but we couldn't do much to help. Horus is in the Egyptian Cluster of asteroids, way out of the ecliptic, and it would take any aid mission a couple of weeks to get to them. By that time, I suspected their problem would be over—one way or another. So I was in a pretty gloomy mood when McAndrew and I sat down to dinner.

"I didn't know what to tell them, Mac. They know the score as well as I do, but they couldn't resist asking if we had a fast-passage ship that could help them. I had to tell them the truth; there's nothing that can get out there at better than two and a half gees, not with people on board. And they need doctors, not just drugs. Luna will have something on the way in a couple of days, but I don't think that will do it."

McAndrew nodded sympathetically. He knew that I needed to talk it out with somebody, and we'd spent a lot of time together on those Titan runs. He's working on his own experiments most of the time, but I know when he needs company, too. It must be nice to be a famous scientist, but it can be lonely travelling all the time inside your own head.

"I wonder if we're meant for space, Mac," I went on—only half-joking. "We've got drives that will let us send unmanned probes out at better than a hundred gees of continuous acceleration, but we're the weak link. I could take the *Assembly* here up to five

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gees—we'd be home in a couple of days instead of another month—but you and I couldn't take it. Can't you and some of your staff at the Institute come up with a system so that we don't get crushed flat by high accelerations? A thing like that, an inertia-less drive, it would change space exploration completely."

I was wandering on, just to keep my mind off the problems they had out on Horus, but what I was saying was sound enough. We had the power on the ships, only the humans were the obstacle. McAndrew was listening to me seriously, but he was shaking his head.

"So far as I know, Jeanie, an inertia-less drive is a theoretical impossibility. Unless somebody a lot brighter than I am can come up with an entirely new theory of physics, we'll not see your inertia-less drive."

That was a pretty definitive answer. There *were* no people brighter than McAndrew, at least in the area of physics. He was a full professor at the Penrose Institute, and the System's leading expert on space-time structure. If Mac didn't think it could be done, you'd not find many people arguing with him. A lot of people were fooled by the fact that he took time off to make trips with me out to Titan, but that was all part of his way of working—he said he needed time away from his colleagues, just so he could do his real thinking.

If you deduce from this that I'm not up at that rarefied level of thought, you're quite right. I can follow McAndrew's explanations—sometimes. But when he gets going, my own degrees in Electrical Engineering and Gravitational Engineering don't help a bit. He loses me in the first two sentences.

This time, his words seemed clear enough for anyone to follow them. I poured myself another glass of ouzo and wondered how many centuries it would be before the man with the completely new theory was born. Sitting across from me, McAndrew had begun to rub at his sandy, receding hairline. His expression was vacant. I've learned not to interrupt when he's got that look on his face—it means he's thinking in a way that I can't follow. One of the other professors at the Penrose Institute says that Mac has a mind that can see round corners, and I have a little inkling of what he meant by that.

"Why inertia-less, Jeanie?" said McAndrew after a few minutes.

Maybe he hadn't been listening to me after all. "So we can use high acceleration. So we can get people to go at the same speeds as the unmanned probes. They'd be flattened at fifty gee; you know that. We need an inertia-less drive so that we can stand that acceleration without being squashed to a mush."

"But that's not the same thing at all. I told you that a drive with no inertia isn't possible—and it isn't. What you're asking for, now, it seems to me that we should be able to . . ."

His voice drifted off to nothing, he stood up, and without another word he left the cabin. I wondered what I'd started.

If that was the beginning of the McAndrew drive—as I think it

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was—then, yes, I was there at the very beginning.

So far as I could tell, it wasn't only the beginning. It was also the end. Mac didn't talk about the subject again on our way in to Luna rendezvous, even though I tried to nudge him a couple of times. He was always the same; he didn't like to talk about his ideas when "half-cooked," as he called it.

When we got to Luna, McAndrew went off back to the Institute, and I took a cargo out to Cybele. End of story, and it gradually faded from my thoughts, until the time came, seven months later, for the next run to Titan.

For the first time in five years, McAndrew didn't make the trip. He didn't call me, but I got a brief message that he was busy with an off-Earth project, and wouldn't be free for several months. I wondered, not too seriously, if Mac's absence could be connected with inertia-less spaceships, and then went on with the cargo to Titan.

That was the trip where some lunatic in the United Space Federation's upper bureaucracy decided that Titan was overdue for some favorable publicity, as a thriving colony where culture would be welcomed. Fine. They decided to combine culture and nostalgia, and hold on Titan a full-scale, old-fashioned Miss & Mister Universe competition. It apparently never occurred to the orgnizers—who must have had minds that coud not see in straight lines, let alone around corners—that the participants were bound to take the thing seriously once it was started. Beauty is not something that good-looking people are willing to take lightly. I had the whole Assembly filled with gorgeous, jealous contestants, screaming managers, horny and ever-hopeful newshounds from every media outlet in the System, and any number of vengeful and vigilant wives, lovers, and mistresses of both sexes. On one of my earlier runs I took a circus and zoo out to Titan, but that was nothing compared with this trip. Thank heaven that the ship is computer-controlled. All my time was spent in keeping some of the passengers together and the rest apart.

It also hadn't occurred to the organizers, back on Earth, that a good part of the Titan colony is the prison. When I saw the first interaction of the prisoners and the contestants I realized that the trip out to Titan had been a picnic compared with what was about to follow. I chickened out and went back to the ship until it was all over.

I couldn't really escape, though. When it *was* all over—when the winners had finally been chosen, when the protests and the counter-protests had all been lodged, when the battered remnants of the more persistent prisoners had been carried back to custody, when the mayhem was stilled, and when the colonists of Titan must have felt that they had enjoyed as much of Inner System culture as they could stand for another twenty or thirty years—after all that, it was my job to get the group back on board again, and home to Earth without further violence. The contestants hated their managers, the managers hated the judges, the judges hated the

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newsmedia, and everyone hated the winners. It seemed to me that McAndrew may have had advance information about the trip, and drawn a correct conclusion.

I would like to have skipped it myself. Since I was stuck with it, I separated the sections of the *Assembly* as much as I could, put everything onto automatic, and devoted myself to consoling one of the losers, a smooth-skinned armful from one of the larger asteroids.

We finally got there. On that day of rejoicing, the whole ghastly gaggle connected with the contest left the *Assembly*. I said a lingering farewell to my friend fromVesta—an inappropriate origin for that particular contestant—and settled back for a needed rest.

It lasted for about eight hours. As soon as I called into the Com Center for news and messages, I got a terse summons on the com display: GO TO PENROSE INSTITUTE, L-4 STATION. MACAVITY.

Not an alarming message, on the face of it, but it worried me. It was from McAndrew, and it was addressed to me alone—no one else in the System called him Macavity, and I doubt if three people knew that I had given him that nickname when I found he was a specialist on theories of gravity. (*Old Possum's Book Of Practical Cats* didn't seem to be widely read among Mac's colleagues.)

Why hadn't he called me directly, instead of sending a com-link message? The fact that we were back from Titan would have been widely reported. I sat down at the terminal and placed a link to the Institute, person-to-person to McAndrew.

I didn't feel any better when the call went through. Instead of Mac's familiar face, I was looking at the coal-black complexion of Professor Limperis, the head of the whole Institute. He nodded at me seriously.

"Captain Roker, your timing is impressive. If we had received no response to Professor McAndrew's coded message in the next eight hours, we would have proceeded without you. Can you help?"

He hesitated, seeing my confused expression. "Did your message tell you the background of the problem?"

"Dr. Limperis, all I've had so far is half a dozen words—to go to the L-4 branch of the Institute. I can do that easily enough, but I have no idea what the problem is, or what use I could possibly be on it. Where's Mac?"

"I wish to God I could answer that." He sat silent for a moment, chewing on his lower lip, then shrugged. "Professor McAndrew insisted that we send for you—left a message specifically for you. Hé told us that you were the stimulus for beginning the whole thing."

"*What* whole thing?"

He looked at me in even greater surprise. "Why, the high acceleration drive—the balanced drive that McAndrew has been developing for the past year. McAndrew has disappeared testing the prototype. Can you come at once to the Institute?"

The trip out to the Institute, creeping

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along in the space tug from Luna Station, was one of the low points of my life. There was no particular logic to it—after all, I'd done nothing wrong. But I couldn't get rid of the feeling that I'd wasted a critical eight hours after the passengers had left the *Assembly*. If I hadn't been obsessed with sex on the trip back, maybe I would have gone straight to the com-link instead of taking a sleep break. And maybe then I would have been on my way that much earlier, and that would have been the difference between saving Mac and failing to save him. . . .

You can see how my mind was running. Without any real facts, you can make bears out of bushes just as well in space as you can on Earth. All I had been told by Limperis was the McAndrew had left a week earlier on a test of the prototype of a new ship. If he was not back within a hundred and fifty hours, he had left that terse coded message for me, and instructions—orders might be a better word—to take me along on any attempted search for him.

Dr. Limperis had been very apologetic about it. "I'm only quoting Professor McAndrew, you understand. He said that he didn't want any rescue party setting out in the *Dotterel* if you weren't part of it. He said" —Limperis coughed uncomfortably—"we had a real need for your common sense and natural cowardice. We'll be waiting for you here as soon as you can arrange passage. The least we can do for Professor McAndrew in the circumstances is to honor his wishes on this."

I couldn't decide if I was being complimented or not. As L-4 Station crept into view on the forward screen, I peered at it on highest magnification, trying to see what the rescue ship looked like. I could see the bulk of the Institute structure, but no sign of anything that ought to be a ship. I had visions of a sort of super-*Assembly*, a huge cluster of electromagnetically linked spheres. All I could see were living quarters and docking facilities, and, as we came in to dock, a peculiar construction like a flat, shiny plate with a long thin spike protruding from the center. It looked nothing like any USF ship, passenger or cargo.

Limperis may have spent his whole life in pure research, but he knew how to organize for emergency action. There were just five people in our meeting inside the Institute. I had never met them in person, but they were all familiar to me through McAndrew's descriptions, and from media coverage. Limperis himself had made a life study of high-density matter. He knew every kernel below lunar mass out to a couple of hundred astronomical units—many of them he had visited, and a few of the small ones he had shunted back with him to the Inner System, to use as power supplies.

Siclaro was the specialist in kernel energy extraction. The Kerr-Newman black holes were well-understood theoretically, but efficient use of them was still a matter for experts. When the USF wanted to know the best way to draw off power, for drives or for general use, Siclaro was usually called in. His name on a recommendation was like a stamp

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of approval that few would think to question.

With Gowers there as an expert in multiple kernel arrays, Macedo as the System authority in electromagnetic coupling, and Wenig the master of compressed matter stability, the combined intellect in that one room in the Institute was overpowering. I looked at the three men and two women who had just been introduced to me, and felt like a gorilla in a ballet. I might make the right movements, but I wouldn't know what was going on.

"Look, Dr. Limperis, I know what Professor McAndrew wants, but I'm not sure he's right." Might as well hit them with my worries at the beginning, and not waste everybody's time. "I can run a ship, sure—it's not hard. But I've no idea how to run something with a McAndrew drive on it. Any one of you could probably do a better job."

Limperis was looking apologetic again. "Yes and no, Captain Roker. We could all handle the ship, any one of us. The concepts behind it are simple—a hundred and fifty years old. And the engineering has been kept simple, too, since we are dealing with a prototype."

"Then what do you want *me* for?" I won't say I was angry, but I was uneasy and unhappy, and there's a fine line between irritation and discomfort.

"Dr. Wenig will drive the *Dotterel*; he has handled it before in an earlier test. Actually, he handled the *Merganser*, the ship that Dr. McAndrew has disappeared in, but the *Dotterel* has identical design and equipment. Controlling the ship is easy—if everything behaves as we expected. If something goes wrong—and something must have gone wrong, or McAndrew would be back before this—then neither Dr. Wenig, nor any of the rest of us, has the experience that will be needed. We want you to tell Dr. Wenig what *not* to do. You've been through dangerous times before." He looked pleading. "Will you observe our actions, and use your experience to advise us?"

Uninvited, I flopped down into a seat and stared at the five of them. "You want me to be a bloody canary!"

"A canary?" Wenig was small and slight, with a luxuriant black mustache. He had a strong accent, and I think he was suspecting himself of a translation error.

"Right. Back when people used to go down deep in the Earth to mine coal, they used to take a canary along with them. It was more sensitive to poisonous gases than they were. When it fell off the perch, they knew it was time to leave. The rest of you will fly the ship, and watch for me to fall off my seat."

They looked at each other, and finally Limperis nodded. "We need a canary, Captain Roker. None of us here knows how to sing at the right time. Will you do it?"

I had no choice. Not after Mac's personal cry for help. I could see one problem—I'd be telling them everything they did was dangerous. When you have a new piece of technology, it *is* risky, whatever you do with it.

"You mean you'll let me overrule all the rest of you, if I don't feel comfortable?"

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"We would." Limperis was quite firm about it. "But the question will not arise. The *Merganser* and the *Dotterel* are both two-person ships. We saw no point in making them larger. Dr. Wenig will fly the *Dotterel*, and you will be the only other person. It just takes one person to handle the controls. You will be there to advise of hidden problems."

I stood up. "Let's go. I don't think I can see danger any better than you can, but I may be wrong. If Mac's on his own out there, wherever he is, we'd better get moving. I'm ready when you are, Dr. Wenig."

Nobody moved. Maybe McAndrew and Limperis were right about my antennae, because at that moment I had a premonition of new problems. I looked around at the uncomfortable faces.

"Professor McAndrew isn't actually *alone* on the *Merganser*." It was Olga Gowers who spoke first. "He has a passenger on the ship."

"Someone from the Institute?"

She shook her head. "Nina Velez is with him."

"Nina Velez? You don't mean President Velez's daughter—the one with AG News?"

She nodded. "The same."

I sat down again in my chair. Maybe the Body Beautiful run to Titan had been an easier trip than I had realized.

Wenig may have come to piloting second-hand, but he certainly knew his ship. He wanted me to know it, too. Before we left the Institute, we'd done the lot—schematics, models, components, power, life support, mechanicals, electricals, electronics, controls, and back-ups.

When the ship was explained to me, I decided that McAndrew didn't really see round corners when he thought. It was just that things were obvious to him *before* they were explained, and obvious to other people afterwards. I had been saying "inertia-less" to Mac, and he had been just as often saying "impossible." But we hadn't been communicating very well. All I wanted was a drive that would let us accelerate at multiple gees without flattening the passengers. To McAndrew, that was a simple requirement, one that he could easily satisy—but there was no question of doing away with inertia, of passengers or ship.

"Take it back to basics," said Wenig, when he was showing me how the *Dotterel* worked. "Remember the equivalence principle? That's at the heart of it. There is no way of distinguishing an accelerated motion from a gravitational field force, right?"

I had no trouble with that. It was freshman physics. "Sure. You'd be flattened just as well in a really high gravity field as you would in a ship accelerating at fifty gees. But where does it get you?"

"Imagine that you were standing on something with a hefty gravity field—Jupiter, say. You'd experience a downward force of about two and a half gees. Now suppose that somebody could accelerate Jupiter *away* from you, downwards, at two and a half gee. You'd fall towards it, but you'd never reach it—it would be accelerating at the

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same rate as you are. You'd feel as though you were in free fall, but so far as the rest of the universe is concerned you'd be accelerating at two and a half gees, same as Jupiter. That's what the equivalence principle is saying, that acceleration and gravity can cancel out, if they're set up as equal and opposite."

As soon as you got used to Wenig's accent, he was easy to follow—I doubt if anybody could get into the Institute unless he was more than bright enough to explain concepts in easy terms. I nodded vigorously.

"I can understand that easily enough. But you've just replaced one problem with a worse one. You can't find any drive in the universe that could accelerate Jupiter at two and a half gees."

"We cannot—not yet, at any rate. Luckily, we don't need to use Jupiter. We can do it with something a lot smaller, and a lot closer. Let's look at the *Dotterel* and the *Merganser*. At McAndrew's request I designed the mass element for both of them."

He went across the window that looked out from the inside of the Institute to raw space. The *Dotterel* was floating about ten kilometers away, close enough to see the main components.

"See the plate on the bottom? It's a hundred-meter-diameter disk of compressed matter, electromagnetically stabilized and one meter thick. Density's about eleven hundred and seventy tons per cubic centimeter—pretty high, but nothing near as high as we've worked with here at the Institute. Less than you get in anything but the top couple of centimeters of a neutron star, and nowhere near approaching kernel densities. Now, if you were sitting right at the center of that disk, you'd experience a *gravitational* acceleration of fifty gees pulling you down to the disk. Tidal forces on you would be one gee per meter—not enough to trouble you. If you stayed on the axis of the disk, and moved away from it, you'd feel an attractive force of *one* gee when you were two hundred and forty-six meters from the center of the disk. See the column growing out from the disk? It's four meters across and two hundred and fifty meters long."

I looked at it through the scope. The long central spike seemed to be completely featureless, a slim column of grey metal.

"What's inside it?"

"Mostly nothing." Wenig picked up a model of the *Dotterel* and cracked it open lengthwise, so that I could see the interior structure. "When the drives are off, the living capsule is out here at the far end, two hundred and fifty meters from the dense disk. Gravity feels like one gee, towards the center of the disk. See the drives here, on the disk itself? They accelerate the whole thing *away* from the center column, so the disk stays flat and perpendicular to the motion. The bigger the acceleration that the drives produce, the closer to the disk we move the living capsule, up the central column here. We keep it so the total force in the capsule, gravity less acceleration, is always one gee, *towards* the disk."

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He slid the capsule along an electromechanical ladder closer to the disk. "It's easy to compute the right distance for any acceleration—the computer has it built in, but you could do it by hand in a few minutes. When the drives are accelerating the whole thing at fourteen gees, the capsule is held a little less than fifty meters from the disk. I've been on a test run in the *Merganser* where we got up to almost twenty gees. Professor McAndrew intended to take it up to higher accelerations on this test. To accelerate at thirty-two gees, the capsule must be about twenty meters from the disk to keep effective gravity inside it to one gee. The plan was to take the system all the way up to design maximum—fifty gees thrust acceleration, so that the passengers in the capsule would be right up against the disk, and feel as though they were in free fall. Gravity and thrust accelerations will exactly balance."

I was getting goose bumps along the back of my neck. I knew the performance of the unmanned med ships. They would zip from inside the orbit of Mercury out to Pluto in a couple of days, standing start to standing finish. Once in a while you'd get a passenger on them—accident or suicide. The flattened thing that they unpacked at the other end showed what the human body thought of a hundred gees.

"What would happen if the drives went off suddenly?" I said.

"You mean when the capsule is up against the disk—at maximum thrust?" Wenig shook his head. "We designed a safeguard system to prevent that, even on the prototypes. If there were a sign of the drive cutting off, the capsule would be moved back up the column, away from the disk. The system for that is built-in."

"Yeah. But McAndrew hasn't come back." I had the urge to get on our way. "I've seen built-in safe-systems before. The more foolproof you think something is, the worse the failure when it happens. Can't we get moving?"

"Come on." Wenig stood up. "Any teacher will tell you, you can't get much into an impatient learner. I'll give you the rest of the story as we go. We'll go out along the same path as McAndrew did—that's plotted out in the records back here."

"You think McAndrew went along with the nominal flight plan?"

"We know he didn't." Wenig looked a lot less sure of himself. "You see, when the drives are on maximum, the plasma around the life-capsule column interferes with radio signals. Fifty hours after they left the Institute, the *Merganser* was tracked from Oberon Station. McAndrew came back into the solar system, decelerating at fifty gees. He didn't cut the drive at all—just went right through the system and accelerated out again in a slightly different direction. We got the log, but we've no idea what he was doing—there was no way to get a signal to him or from him with the drive on."

"So they got all the way up to the maximum drive! And they came back here. God, why didn't Limperis tell me that when we were in the first meeting?" I went to the locker and pulled

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out a suit. "He took it up all the way, fifty gees or better. Let's get after him. If he kept that up, they'll be half-way to Alpha Centauri by now. If they're alive."

The living capsule was about three meters across and simply furnished. I was surprised at the amount of room there was, until Wenig pointed out to me how equipment and supplies that could take higher accelerations were situated on the outside of the capsule, on the side away from the gravity disk.

We had started with McAndrew's flight plan for only a few minutes when I took Limperis at his word that I'd be boss and changed the procedure. If we were to reach McAndrew, the less time we spent shooting off in the opposite direction to the one that he had gone, the better. He had come right through the system, and we ought to head in the direction that he was last seen to be heading.

"I'll take us up to fifty gees," said Wenig. "That way, we'll experience the same perturbing forces as the *Merganser* did. All right?"

"Christ, no." My stomach turned over. "Not all right. Look, we don't know what happened to Mac, but chances are it was some problem with the ship. If we do just what he did, we may finish up with the same trouble."

Wenig took his hands off the controls and turned to me, palms spread. "But then what can we do? We don't know where they were going. All we can do is try and follow the same track."

"I'm not sure. All I know is what we're *not* going to do—and we're not trying for top acceleration. Didn't you say you'd flown *Merganser* at twenty gees?"

"Several times."

"Then take us out along Mac's trajectory at twenty gees until we're outside the system. Then cut the drive. I want to use our sensors, and we won't be able to do that from the middle of a ball of plasma."

Wenig looked at me. I know he was mentally accusing me of cowardice. "Captain Roker," he said quietly. "I thought we were in a hurry. We may be weeks following *Merganser* the way you are proposing."

"Yeah. But we'll get there. Can Mac's support system last that long?"

"Easily."

"Then don't let's kick it around any more. Let's do it. Twenty gees, as soon as you can give it to us."

The *Dotterel* worked like a dream. At twenty gees acceleration relative to the solar system, we didn't feel anything unusual at all. The disk pulled us towards it at twenty-one gees, the acceleration of the ship pulled us away from it at twenty gees, and we sat there in the middle at a snug and comfortable standard gravity. I couldn't even feel the tidal forces, though I knew they were there. We had poor communications with the Penrose Institute, but we'd known of that and expected to make up for it when we cut the drive.

Oddly enough, the first phase of the trip wasn't scary—it was boring. I wanted to get up to a good cruise speed before we coasted free. It gave me the

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chance to probe another mystery—one that seemed at least as strange as the disappearance of the *Merganser*.

"What were you doing at the Institute, allowing Nina Velez aboard the ship?"

"She heard that we were developing a new drive—don't ask me how. Maybe she saw the Institute's budget." Wenig sniffed. "I don't trust the security at the USF Headquarters."

"And you let her talk her way in, and you forced McAndrew to take her with him on a *test flight*?"

If I sounded mad, I felt madder. Mac's life meant more than the dignity of some smooth-assed bureaucrat in the Institute's front office.

Dr. Wenig looked at me coldly. "I think you misunderstand the situation. Nina Velez was not forced onto Professor McAndrew by the 'front office'—for one thing, we have no such thing. The Institute is run by its members. You want to know why Miss Velez is on board the *Merganser*? I'll tell you. McAndrew insisted that she go with him."

"Bullshit!" There were some things I couldn't believe. "Why the hell would Mac let himself go along with that? I know him, even if you don't. Over his dead body."

Wenig sighed. He was leaning on a couch across from me, sipping a glass of white wine—no hardship tours for him.

"Four weeks ago I'd have echoed your comments exactly," he said. "Professor McAndrew would never agree to such a thing, right? But he did. Putting this simply, Captain Roker, it is a case of infatuation. A bad one. I think that—"

He stopped, outraged. I had started to laugh, in spite of the seriousness of our situation.

"What's so funny, Captain?"

"Well," I shrugged. "The whole thing's funny. Not funny, it's preposterous. McAndrew is a great physicist, and Nina Velez may be the president's daughter, but she's just a young newswoman. He wouldn't—"

Now I stopped. I wondered if Wenig was going to get up and hit me, he looked so mad.

"Captain Roker, I don't like your insinuation" he said. "McAndrew is a physicist—so am I. You may not be smart enough to realize it, but physics is a field of study, not a surgical operation. Castration isn't part of the Ph.D. exams, you know." His tone dripped sarcasm. I wouldn't have liked a two-month trip to Titan with young Dr. Wenig.

"Anyway," he went on. "You have managed to jump to a wrong conclusion. It was not Professor McAndrew that suffered the initial infatuation. It was Nina Velez. She thinks he is wonderful. She came to do an interview, and before any of us knew what was going on she was in his office all day. All night, too, after the first week."

I was wrong. I know that now, and I think I knew it then, but I wasn't big enough to make an immediate apology to Wenig. Instead, I said, "But if she was the one that wanted him, couldn't he just throw her out?"

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"Nina Velez?" Wenig gave a bark of laughter. "You've never met her, I assume? She's a president's daughter, and whatever Nina wants, Nina gets. She started it, but inside a couple of days she had Professor McAndrew behaving like a true fool. It was disgusting, the way he went on."

(You're jealous, I said, jealous of Mac's good luck—but I said it to myself.)

"And she persuaded McAndrew to let her go out on the *Merganser*? What were the rest of you doing?"

He reddened. "Professor McAndrew was not the only one behaving like a fool. Why do you think Limperis, Siclaro, and I feel like murderers? The two women on the team, Gowers and Macedo, insisted that Nina Velez should not go near the ships. We overruled them. Now, Captain Roker, maybe you see why each of us wanted to come after McAndrew. We drew lots, and I was the winner.

"And maybe you should think of one other thing," he went on. "While you are looking at our motives, and laughing at them, maybe you ought to look at your own. You look angry. I think you are jealous—jealous of Nina Velez."

It's a good thing that we had to follow our flight plan at that point, and prepare to cut the drive, or I don't know what I would have done to Dr. Wenig. I'm a shade taller than he is, and I outweigh him by maybe ten pounds, but he looked fit and wiry. It wouldn't have been a foregone conslusion, not at all.

Our descent into savagery was saved by the insistent buzzer of the computer, telling us to be ready for the drive reduction. We sat there, furious and not looking at each other, as the acceleration was slowly throttled back and the capsule moved away from the disk to resume its free-flight position two hundred and fifty meters behind it. The move took ten minutes. By the time it was over we had cooled off. I managed a graceless apology for my implied insults, and Wenig uncomfortably accepted it and said that he was sorry for what he had been saying and thinking.

I didn't ask him what he *had* been thinking—there was a hint that it was much worse than anything that he had said.

We had cut the drive at a little more than one hundred astronomical units from the sun and were coasting along at a quarter of the speed of light. The computer gave us automatic Doppler compensation, so that we could hold an accurate communication link back to the Institute, through Oberon Station. Conversation wasn't easy, because the round-trip delay for signals was almost twenty-eight hours—all we expected to be able to do was send "doing fine" messages to Limperis and the others.

Our forward motion was completely imperceptible, though I fancied that I could see a reddening of stars astern and a bluer burn to stars ahead of us. We were out well beyond the edge of the planetary part of the system, out where only the comets and the kernels lived. I put all our sensors onto maximum gain and Wenig and I settled in to a quiet spell of close watching. He had asked me what we were looking for. I had told

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him the truth: I had no idea, of what or when.

We crept on, further out. I don't know if you can creep, at a quarter of light speed, but that's the way it felt; blackness, the unchanging stars, and a dwarfed solar system far behind us.

Our eyes were all wide open; radio receivers, infra-red scanners, telescopes, flux meters, radar, and mass detectors. For two days we found nothing, no signal above the hiss and shimmer of the perennial interstellar background. Wenig was growing more impatient, and his tone was barely civil. He wanted us to get the drive back on high, and dash off after McAndrew —wherever that might be.

He was fidgeting on his bunk and ignoring the scopes when I saw the first trace.

"Dr. Wenig. What am I seeing? Can you tune that IR receiver?"

He came alert and was over to the console in a single movement. After a few seconds of adjustment he shook his head and swore. "It's natural, not man-made. Look at that trace. We're seeing a hot collapsed body. About seven hundred degrees, that's why there's peak power in the five-micrometer band. We can call back to Limperis if you like, but he's sure to have it in his catalog already. There must be lots of these within a few days flight of us."

He left the display and slumped back on his bunk. I went over and stared at it for a couple of minutes. "Would McAndrew know that this is here?"

That made him think instead of just brooding. "There's a good chance that he would. Collapsed and high-density matter is Doctor Limperis's special study, but McAndrew probably put a library of them into *Merganser*'s computer before he left. He wouldn't want to run into something unexpected out here."

"We have McAndrew's probable trajectory stored there too?"

"We know how he left the system, where he was heading. If he cut the drive, or turned after he was outside tracking range, we don't have any information on it."

"Never mind that. Give me the library access codes, and let me get at the input console. I want to see if Mac's path shows intersection with any of the high-density objects out here."

Wenig looked skeptical. "The chances of such a close encounter are very small. One in millions or billions."

I was already calling up the access sequence. "If by accident I'd agree with you. But McAndrew must have had some reason to fly back through the system, and make the slight course change that you recorded. I think he was telling us where he was going. And the only place he could have been going between here and Sirius would be one of the collapsed bodies out in the Halo."

"But *why*?" Wenig was standing at my shoulder, fingers twitching.

"Don't know that." I stood up. "Here, you do it, you must have had plenty of experience with *Dotterel*'s computer. Set it for anything that would put *Merganser* within five million kilometers of a high-density body. That's

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as close as I think we can rely on trajectory intersection."

Wenig's fingers were flying over the keys—he should have been a concert pianist. I've never seen anybody handle a programming sequence at that rate. While he was doing it the com-link whistled for attention. I turned to it, leaving Wenig calling out displays and index files.

"It's Limperis," I said. "Problems. President Velez is starting to breathe down his neck. Wants to know what has happened to Nina. When will she be back? Why did Limperis and the rest of you let her go on a test trip? How can the Institute be so irresponsible?"

"We expected that." Wenig didn't look up. "Velez is just blowing off steam. There's no way that any other ship could get out here to us in less than three months. Does he have anything useful to suggest?"

"No. He's threatening Limperis with punitive measures against the Institute. Says he'll want a review of the whole organization."

"Limperis is asking for our reply?"

"Yes."

Wenig keyed in a final sequence of commands and sat back in his seat. "Tell him Velez should go screw himself. We've got enough to do without interference."

I was still reading the incoming signals from Oberon Station. "I think Dr. Limperis has already sent that message to the president's office—not in those words, maybe. We'd better get Nina back safely."

"I know that." Wenig hit a couple of keys and an output stream began to fill the scope. "Here it comes. Closest approach distances for every body within five hundred AU, assuming McAndrew held the same course and acceleration all the way out. I've set it to stop if we get anything better than a million kilometers, and display everything that's five million or closer."

Before I could learn how to read the display, Wenig banged both hands down on the desk and leaned forward.

"Look at that!" His voice showed his surprise and excitement. "See it? That's HC-183. It's 322 AU from the sun, and almost dead ahead of us. The computer shows a fly-by distance for *Merganser* too small to compute—that's an underflow where we ought to see a distance."

"Suppose that McAndrew decelerated as he got nearer to it?"

"Wouldn't make much difference, he'd still be close to rendezvous—speeds in orbit are small that far out. But why would he want to rendezvous with HC-183?"

I couldn't answer that, but maybe we were at least going to find *Merganser*. Even if it was only a vaporized trace on the surface of HC-183, where the ship hit it.

"Let's get back with our drive," I said. "What's the mass of HC-183?"

"Pretty high." Wenig frowned at the display. "We show a five-thousand kilometer diameter and a mass that's half of Jupiter's. Must be a good lump of collapsed matter at the center of it. How close do you want to take us? And what acceleration for the drive?"

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"Give us a trajectory that lets us take a close look from bound orbit. A million kilometers ought to be enough. And keep us down to twenty gees or better. I'll send a message back to the Institute. If they have any more information on HC-183, we want it."

Wenig had been impatient before, when we weren't going anywhere in particular. Now that we had a target, he couldn't sit still. He was all over our three-meter living capsule, fiddling with the scopes, the computer, and the control console. He kept looking wistfully at the drive setting, then at me.

I wasn't having any. I felt as impatient as he did, but when we had come this far I didn't want to find we'd duplicated *all* McAndrew's actions, including the one that might have been fatal. We smoothly turned after twenty-two hours, so our drive began to decelerate us, and waited out the interminable delay as we crept closer to the dark mass of HC-183. We couldn't see a sign of it on any of the sensors, but we knew it had to be there, hidden behind the plasma ball of the drive.

When the drive went off and we were in orbit around the black mass of the hidden proto-planet, Wenig was at the display console for visible wavelengths.

"I can see it!" he shouted.

My first feeling of relief and excitement lasted only a split second. There was no way we would be able to spot the *Merganser* from a million kilometers out.

"What are you seeing? Infra-red emission from HC-183?"

"No, you skeptic. I can see the ship—McAndrew's ship."

"You can't be. We'd have to be right next to it to be able to pick it up with our magnifications." I spun my seat around and looked at the screen.

Wenig was laughing, hysterical with relief. "Don't you understand? I'm seeing the *drive*, not *Merganser* itself. Look at it, isn't it beautiful?"

He was right. I felt as though I was losing my reason. McAndrew might have gone into orbit about the body, or if he were unlucky he might have run into it—but it made no sense that he'd be sitting here with the drive on. And from the look of the long tail of glowing plasma that stretched across twenty degrees of the screen, that drive was on a high setting.

"Give me a Doppler read-out," I said. "Let's find out what sort of orbit he's in. Damn it, what's he doing there, sight-seeing?"

Now that it looked as though we had found them, I was irrationally angry with McAndrew. He had brought us haring out beyond the limits of the system, and he was sitting there waiting when we arrived. Waiting, and that was all.

Wenig had called up a display and was sitting there staring at it in perplexity. "No motion relative to HC-183," he said. "He's not in an orbit around it, he's got the ship just *hanging* there, with the drive balancing the gravitational attraction. Want me to take us alongside, so we can use a radar signal? That's the only way he'll hear us through the drive interference."

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"I guess we'll have to. Take us up close to them." I stared at the screen, random thoughts spinning around my head. "No, wait a minute. Damn it, once we set up the computer to take us in there, it will do automatic drive control. Before we go in, let's find out what we're in for. Can you estimate the strength of HC-183's gravitational attraction at the distance that *Merganser* is at? Got enough data for it?"

"Give me a second." Wenig's fingers flew over the console again. If he ever decided that he didn't want to work at the Penrose Institute, he'd make the best space-racer in the system.

He looked at the output for a second, frowned, and said, "I think I must have made an error."

"Why?"

"I'm coming up with a distance from the surface of about nine thousand kilometers. That means the *Merganser* would be feeling a pull of fifty gees—their drive would be full on, as high as it's designed to go. It wouldn't make sense for them to hang there like that, on full drive. Want to go on down to them?"

"No. Hold it where we are." I leaned back and closed my eyes. "There has to be a pattern to what Mac's been doing. He went right through the system back there with the drive full on, now he's hanging close in to a high-density object with the drive still full on. What the hell's he up to?"

"You won't find out unless we can get in touch with him." Wenig was sounding impatient again. "I say we should go on down there. Now we know where he is, it's easiest to just go and ask him."

It was hard to argue with him, but I couldn't get an uneasy feeling out of the back of my head. Mac was holding a constant position, fifty gees of thrust balancing the fifty-gee pull of HC-183. We couldn't get alongside him unless we were willing to increase *Dotterel*'s drive to fifty gees.

"Give me five more minutes. Remember why I'm here. It's to keep you from doing anything too brave. Look, if we were to hang on our drive with a twenty-gee thrust, how close could we get to the *Dotterel*?"

"We'd have to make sure we didn't fry them with our drive," said Wenig. He was busy for a couple of minutes at the computer, while I tried again to make sense of the pieces.

"We can get so we're about sixty thousand kilometers from them," said Wenig at last. "If we want to talk to them through the microwave radar link, the best geometry would be one where we're seeing them side-on. We'd have decent clearance from both drives there. Ready to do it?"

"One minute more." I was getting a feeling, a sense that everything that McAndrew had done had been guided by a single logic. "Look, I asked you what would happen if the drive failed when the life capsule was up close to the mass disk, and you said the system would move the capsule back out again. But look at it the other way round now. Suppose the drive works fine—and suppose it was the system that's supposed to move the life capsule up and down

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the column that wouldn't work? What would that do?"

Wenig stroked at his luxuriant mustache. "I don't think it could happen, the design looked good. If it did happen, everything would depend where the capsule stuck."

"Suppose it stuck up near the disk, when the ship was on a high-thrust drive?"

"Well, that would mean there was a big gravitational acceleration. You'd have to cancel it out with the drive, or the passengers would be flattened." He paused. "It would be a bugger. You wouldn't dare to turn the drive *off*—you'd need it on all the time, so that your acceleration compensated for the gravity of the disk."

"Damn right. If you couldn't get yourself farther from the disk, you'd be forced to keep on accelerating. That's what happened to the *Merganser*, I'll bet my ass and hat on it. Get the designs of the capsule movement-train up on the screen and let's see if we can spot anything wrong with it."

"You're an optimist, Captain Roker." He shrugged. "We can do it, but those designs have been looked at twenty times. Look, I see what you're saying, but I find it hard to swallow. What was McAndrew doing when he came back through the system and then out again?"

"The only thing he *could* do. He couldn't switch the drive off, even though he could turn the ship around. He could fly off to God knows where in a straight line—that way we'd never have found him. Or he could fly in bloody great circles, and we'd have been able to see him but never get near to him for more than a couple of minutes at a time—there's no other manned ship that could match that fifty-gee thrust. Or he could do what he did do. He flew back through the system to tell us the direction he was heading, out to HC-183. And he balanced here on his drive tail, and sat and waited for us to get smart enough to figure out what he was doing."

I paused for breath, highly pleased with myself. Out of a sphere of trillions of cubic miles, we had tracked the *Merganser* to its destination. Wenig was shaking his head and looking very unhappy.

"What's wrong," I said cockily. "Find the logic hard to follow?"

"Not at all. A rather trivial exercise." He looked down his nose at me. "But you don't seem able to follow your own ideas to a conclusion. McAndrew knows all about *this* ship. He knows it can accelerate at the same rate as *Merganser*. So your idea that he couldn't fly around in big circles and wait for us to match his position can't be right—the *Dotterel* could do that."

He was rght. "So why didn't Mac do that? Why did he come out all this way?"

"I can only think of one answer. He's had the chance to look at the reason the life capsule can't be moved back along the axis, so the drive mustn't be switched off. And he thinks that this ship has the same problem."

I nodded. "See now why I wouldn't let you take the *Dotterel* all the way up to fifty gees?"

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"I do. You were right, and I would have taken us into trouble if you hadn't been along. Now then"—Wenig looked gloomier than ever at some new thought—"let's take the logic a step farther. McAndrew is hanging down there near HC-183 in a fifty-gee gravity field. We can't get there to help him unless we do the same—and we're agreed that we daren't do that, or we'll end up with the same difficulty that he has, and we won't be able to turn off the drive."

I looked out of the port, towards the dark bulk of HC-183 and the *Merganser*, hovering on its plume of high-temperature plasma. Wenig was right. We daren't go down there.

"So how are we going to get them out?"

Wenig shrugged. "I wish I could tell you. Maybe McAndrew has an answer. If not, they're as inaccessible as if they were halfway to Alpha Centauri and still accelerating. We've got to get into communication with them."

When I was about eleven years old, just before puberty, I had a disturbing series of dreams. Night after night, for maybe three months, I seemed to wake on the steep face of a cliff. It was dark, and I could barely see handholds and toeholds in the rock.

I had to get to the top—something was hidden below, invisible behind the curve of the black cliff face. I didn't know what it was, but I knew it was awful.

Every night I would climb, as carefully as I could; and every night there would come a time when I missed a handhold, and began to slide downwards, down into the pit and the waiting monster.

I woke just as I reached the bottom, just as I was waiting for the first sight of my pit beast.

I never saw it. Puberty arrived, sex dreams replaced my fantasy. I forgot all about the cliff face, the terror, the feeling of force that could not be resisted. Forgot it totally—except that dream memories never disappear completely, they lie at some submerged level of the mind, until something pulls them out again.

And here I was again, back on the same cliff face, sliding steadily to my fate, powerless to prevent it. I woke up with my heart rate higher by thirty beats a minute, with cold perspiration on my forehead and neck. It took me a long time to return to the present, to banish the bygone fall into the pit.

I finally forced myself up to full consciousness and looked at the screen above me. The purple blaze of a plasma drive danced against the black backdrop of HC-183 and its surrounding star field. It hung there, falling forever but suspended on the feathery stalk of the drive exhaust. I lay there for about ten minutes, just watching, then looked across at Wenig. He was staring at me, his eyes unblinking.

"Awake at last." He made a sort of coughing noise, something that I think was intended to be a laugh. "You're a cool one, Captain Roker. I couldn't sleep with that hanging there"—he jerked his thumb at the screen—"even

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if you doped me up with everything in the robodoc."

"How long did I sleep?"

"About three hours. Ready to give up now?"

I was. It had been my idea, an insistence that we ought to try and get some sleep before we did the next phase of our maneuver around HC-183. Wenig had opposed it, had wanted to go on at once, but I thought we'd benefit from the rest. So I was wrong.

"I'm ready." My eyes felt as though they'd been filled with grit and my throat was dry and sore, but talking about that to Wenig wouldn't do much for McAndrew or Nina Velez. "Let's get into position and try the radar."

While Wenig juggled us over to the best position, sixty thousand kilometers from HC-183 and about the same distance from the *Merganser*, I wondered again about my companion. They had drawn lots to come with me, and he had won. The other four scientists back at the Institute seemed a little naïve and unworldly, but not Wenig. He was tough and shrewd, and I had seen the speed of those hands, dancing over the keyboard. Had he done a bit of juggling when they drew lots, a touch of hand-faster-than-the-eye? I thought of his look when he spoke about Nina. If McAndrew was infatuated, perhaps Wenig shared the spell. Something strong was driving him along, some force that could keep him awake and alert for days on end. I wouldn't know if I was right or not unless we could find a way to haul *Merganser* back out of the field. The ship still hovered over its pendant of blue ionized gases, motionless as ever.

"How about this?" Wenig interrupted my thoughts. "I don't think I can get the geometry any better than it is now."

We were hanging there too, farther out from the proto-planet than *Merganser* but close enough to see the black disk occluding the star field. We could beam short bursts of microwaves at our sister ship and hope there was enough signal strength to bore through the sheaths of plasma emitted by the drives. It would be touch and go—I had never tried to send a signal to an unmanned ship on high-drive, but our signal-to-noise ratio stood right on the borderline of system acceptance. As it was, we'd have to settle for voice-links only.

I nodded, and Wenig sent out our first pulses, the simple ship I.D. codes. We sent it for a couple of minutes, then waited with our attention fixed on the screen.

After a while Wenig shook his head. "We're not getting through. It wouldn't take that long to respond to our signal."

"Send it with reduced information rate and more redundancy. We have to give McAndrew enough to filter out the noise."

He was still in send mode when the display screen began to crawl with green patterns of light. Something was coming in. The computer was performing a frequency analysis to pick out the signal content from the background, smoothing it, and speeding it up to standard communication rate. We were looking at the Fourier analysis that pre-

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ceded signal presentation.

"Voice mode," said Wenig quietly.

"*Merganser.*" The computer reconstruction of McAndrew's voice was slow and hollow. "This is McAndrew from the *Merganser*. We're certainly glad to hear from you, *Dotterel*. Well, Jeanie, what kept you?"

"Roker speaking." I leaned forward and spoke into the vocal input system—too fast, but the computer would take care of that at the other end. "Mac, we're hanging about sixty kay out from you. Is everything all right in *Merganser*?"

"Yes."

"No," broke in another voice. "Get us out of here. We've been stuck in this damned metal box for sixteen days now."

"Nina," said Wenig. "We'd love to get you out—but we don't know how. Didn't Dr. McAndrew tell you the problem?"

"He said we couldn't leave here until the other ship you're on came for us."

Wenig grimaced at me and turned away from the input link. "I ought to have realized that. McAndrew hasn't told her the problem with the drives—not all of it."

"Maybe he knows an answer." I faced back to the microphone. "Mac, as we see it, we shouldn't put the *Dotterel* up as high as fifty-gee thrust. Correct?"

"Of course." McAndrew sounded faintly surprised at my question. "Why do you think I went to such lengths to get to this holding position out here? When you go to maximum setting for the drive, the electro-mechanical coupling for moving the life capsule gets distorted, too."

"How did we miss it on the design?" Wenig sounded unconvinced.

"Remember the last-minute increase in stabilizing fields for the mass plate?"

"It was my recommendation—I'm not likely to forget it."

"We re-calculated the effects on the drive and on the exhaust region, but not the magnetostrictive effects on the life-support column. We thought they were second-order changes."

"And they're not? I ought to be drawn and quartered—that was my job!" Wenig was sitting there, fists clenched and face red.

"Was it now? Och, your job, eh? And I've been sitting here thinking all this time it was my job." For someone in a hopeless position thirty billion miles from home, McAndrew sounded amazingly cool. "Come on now, we can sort out whose doing it was when we're all back at the Institute."

Wenig looked startled, then turned to me again. "Go along with him on this—I'm sure he's doing it for Nina's sake. He doesn't want her worried."

I nodded—but this time I was unconvinced. Mac must have something hidden away inside his head, or not even Nina Velez would justify his optimistic tone.

"What should we do, Mac?" I said. "We'd get the same effects if we were to accelerate too hard. We can't get down to you, and you can't get up to us without accelerating out past us. How are we going to get you out of

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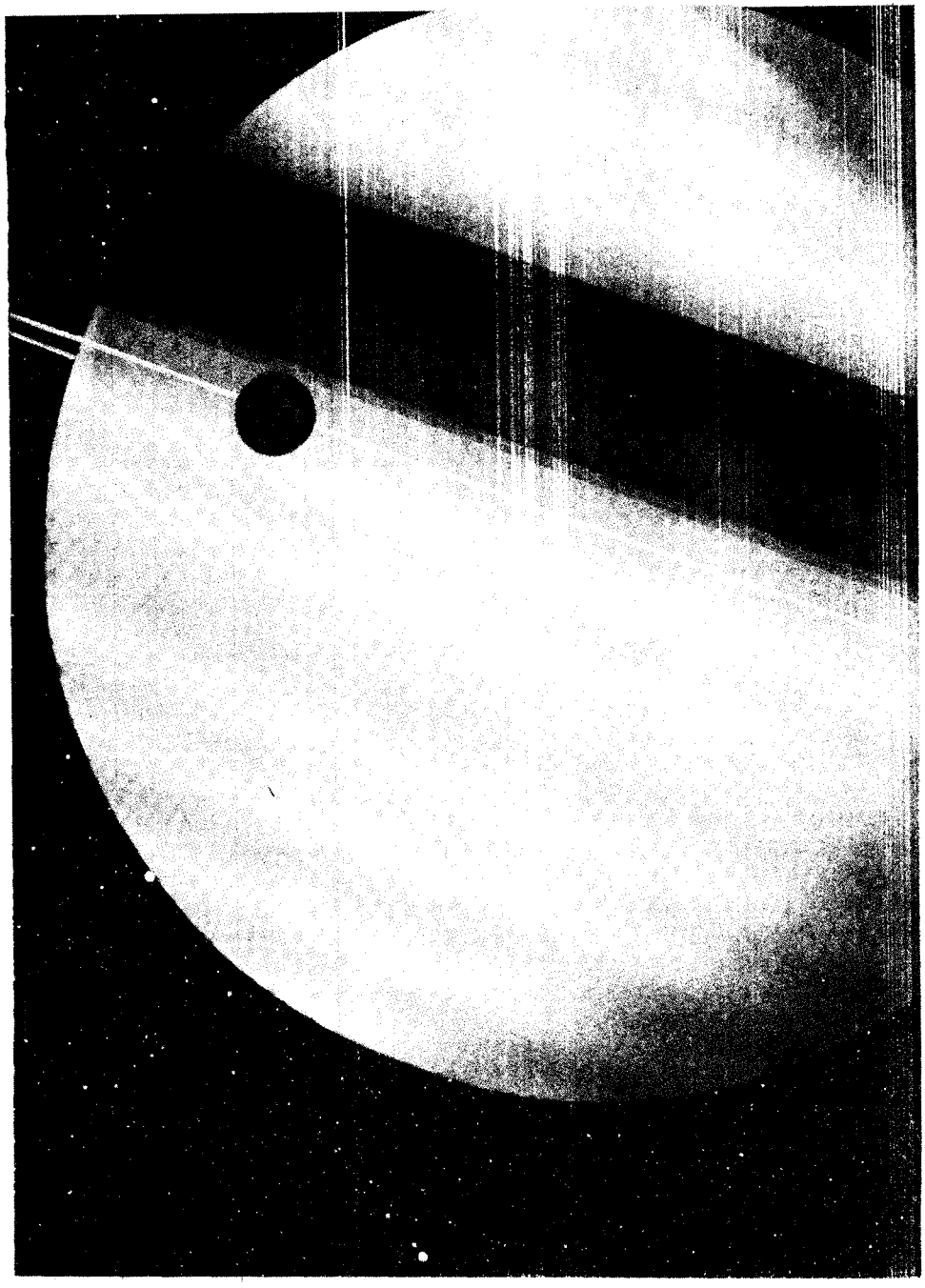

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there all in one piece?"

"Right." The laugh that came over the com-link sounded forced and hollow, but that may have been just the tone that the computer filters gave it. "You might guess that's been on my mind too. The problem's in the mechanical coupling that moves the life capsule along the column. It's easy enough to see, once you imagine that you've had a two millimeter decrease in column diameter—that's the effects of the added field on the mass plate."

Wenig was already calling the schematics out onto a second display. "I'll check that. Keep talking."

"You'll see that when the drive's up to maximum, the capsule catches on the side of the column. It's a simple ratchet effect. I've tried varying the drive thrust up and down a couple of gee, but that won't free it."

"I see where you mean." Wenig had a light-pen out and was circling parts of the column for larger scale displays. "I don't see how we can do anything about it. It would take a lateral impact to free it—you'll not do it by varying your drive."

"Agreed. We need some lateral force on us. That's what I'm hoping you'll provide."

"What is all this?" It was Nina's voice again, and she sounded angry. "Why do you just keep on talking like that? Anybody who knew what he was doing would have us out by now—would never have got into it in the first place if he had any sense."

I raised an eyebrow at Wenig. "The voice of infatuation? I think the bloom's off the rose down there."

He looked startled, then pleased, then excited—and then tried to look nonchalant. "I don't know what McAndrew is getting at. How could we provide any help from here?" He turned to the input system. "Dr. McAndrew, how's that possible? We can't provide a lateral force on *Merganser* from here, and we can't come down safely."

"Of course you can." McAndrew's voice sounded pleased, and I was sure he enjoying making the rest of us try and work out his idea. "It's very easy for you to come down here."

"How, Mac?"

"In a free-fall trajectory. We're in a fifty-gee gravity field because we're in a stationary position relative to HC-183. But if you were to let yourself fall in a free orbit, you'd be able to swing in right past us, and away again, and never feel anything but free-fall. Agreed?"

"Right. We'd feel tidal effects, but they'd be small." Wenig was calling out displays as he talked, fingers a blur over the computer console. "We can fly right past you, but we'd be there and away in a split second. What could we do in so short a time?"

"Why, what we need." McAndrew sounded surprised by the question. "Give us a good bang on the side as you go by."

It sounded easy, as McAndrew so glibly and casually suggested it. When we went into details, there were three problem areas. If we went too close, we'd be fried in the *Merganser*'s drive. Too far off, and we'd never get a strong

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enough interaction. If all that was worked out correctly, we still had one big obstacle. For the capsule to be freed as *Dotterel* applied sideways pressure, the drive on the other ship would have to cut off completely. Only for a split second, but during that time McAndrew and Nina would feel a full fifty gees on them.

That's not quite as bad as it sounds—people have survived instantaneous accelerations of more than a hundred gee in short pulses. But it's not a picnic, either. Mac continued to sound cheerful and casual, mainly for Nina Velez's benefit. But when he listed the preparations that he was taking inside *Merganser*, I knew he was dealing with a touch-and-go situation.

After all the calculations (performed independently on the two ships, cross-checked and double-checked) we started our free-fall orbit. It was designed to take us skimming past the *Merganser*, with a closest separation of less than two hundred meters. We daren't go nearer without risking crippling effects from their drive. We would be flying right through its region of turbulence.

Four hours of discussion between McAndrew and Wenig—with interruptions from Nina and me—had fixed the sequence for the vital half-second when we would be passing the *Merganser*. The ships would exert gravitational forces on each other, but that was useless for providing the lateral thrust on the life capsule system that McAndrew thought was needed. We had to give a more direct and harder push some other way.

Timing was crucial, and very tricky. Whatever we threw at the other ship would have to pass through the drive exhaust region before it could impact the life capsule column. If the drive were on, nothing could get through it—at those temperatures it would be vaporized on the way, even if it were there for only a fraction of a second. The sequence had to be: launch mass from *Dotterel*; just before it got there, kill drive on *Merganser*; hold drive off just long enough for *Dotterel* to clear area and for the mass to impact *Merganser* support column; and back on with their drive, at once, because when the drive was off *Merganser*'s passengers would be feeling the full fifty gees of the mass plate's gravity.

McAndrew and Wenig cut the time of approach of the two ships into millisecond pieces. They decided exactly how long each phase should last. Then they let the two on-board computers of the ships talk to each other, to make sure that everything was synchronized between them—at the rate things would be happening, there was no way that humans could control them. Not even Wenig, with his super-fast reflexes. We'd all be spectators, while the two computers did the real work and I nursed the abort switch.

There was one argument. McAndrew had wanted to use a storage tank as the missile that we would eject from our ship to impact theirs. It would provide high momentum transfer for a very brief period. Wenig argued that we should trade off time against intensity, and use a liquid mass instead of a solid one.

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Endless discussion and calculations, until Mac was convinced too. We would use all our spare water supply, about a ton and a half of it. That left enough for drinking water on a twenty-gee return to the inner system, but nothing spare for other uses. It would be a scratchy and smelly trip home for *Dotterel*'s passengers.

Drive off, we felt only the one-gee pull of our mass plate as we dropped in to close approach. On *Merganser*, McAndrew and Nina Velez were lying in water bunks, cushioned with everything soft on the ship. We were on an impact course with them, one that would change to a near-miss after we ejected the water ballast. It looked like a suicide mission, running straight into the blue furnace of their drive.

The sequence took place so fast it was anti-climactic. I saw the drive cut off ahead of us, felt the vibration along the support column as our mass driver threw the ballast hard towards *Merganser*. The brief pulse from our drive that took us clear of them was too quick for me to feel.

We cleared the drive region. Then there seemed to be a wait that lasted for hours. McAndrew and Nina were now in a ship with drive off, dropping towards HC-183. They were exposed to the full fifty gees of their mass plate. Under that force, I knew what happened to the human body. It had not been designed to operate when it suddenly weighed more than four tons. Membranes ruptured, valves burst, veins collapsed. The heart had never evolved to pump blood that weighed hundreds of pounds, up a gravity gradient of fifty gee. The only thing that Mac and Nina had going for them was the natural inertia of matter. If the period of high gee was short enough, the huge accelerations would not have time to produce those shattering physical effects.

Wenig and I watched on our screens for a long, long moment, until the computer on *Merganser* counted off the last microsecond and switched on the drive again. If the life capsule was free to move along its column, the computer would now begin the slow climb out of HC-183's gravity well. No action was needed from the passengers. When we completed our own orbit we hoped we would see the other ship out at a safe distance, ready for the long trip home.

And on board the ship? I wasn't sure. If the encounter had lasted too long, we might find no more than two limp and broken sacks of blood, tissue and bone.

It was another long day, waiting until we had carried around in our orbit and could try and rendezvous the two ships. As soon as we were within radar range again, Nina Velez appeared on the comscreen. The drive was cut back, so we could get good visual signals. My heart sank when I saw the expression on her face.

"Can you get over to this ship—quickly?" she said.

I could see why all the professors at the Institute had lost their senses. She was small and slight, with a childlike look of trust, and sad blue eyes. All a sham, according to everything I'd been told, but there was no way of seeing the

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strong personality behind the soft looks. I took a deep breath.

"What's happening there?" I said.

"We're back under low gee drive, and that's fine. But I haven't been able to wake him. He's breathing, but there's blood on his lips. He needs a doctor."

"I'm the nearest thing to that in thirty billion miles." I was pulling a suit towards me, sick with a sudden fear. "I've had some medical training as part of the Master's License. And I think I know what's wrong with McAndrew. He lost part of a lung lobe a couple of years ago. If anything's likely to be hemorraging, that's it. Dr. Wenig, can you arrange a rendezvous with the mass plates at maximum separation and the drives off?"

"I'll need control of their computer." He was pulling his suit on, too. I didn't want him along, but I might need somebody to return to the *Dotterel* for medical supplies.

"What should I be doing?" Thank heaven Nina showed no signs of panic. She sounded impatient, with the touch of President Velez in her voice. "I've sat around in this ship for weeks with nothing to be done. Now we need action but I daren't take it."

"What field are you in now? What net field?"

"One gee. The drive's off now, and we've got the life capsule right out at the end of the column."

"Right. I want you to stay in that position, but set the drive at one gee acceleration. I want Dr. McAndrew in a zero-gee environment to slow the bleeding. Dr. Wenig, can you dictate

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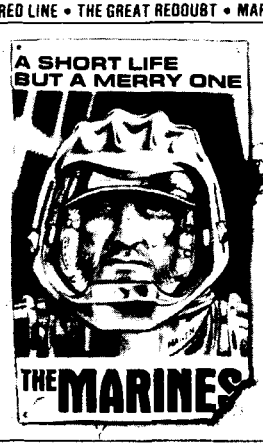

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instructions for that while we are rendezvousing?"

"No problem." He was an irritating devil, but I'd choose him in a crisis. He was doing three things at once, putting on his suit, watching the computer action for the rendezvous, and giving exact and concise instructions to Nina.

Getting from one ship to the other wasn't as easy as it might sound. We had both ships under one-gee acceleration drives, complicated by the combined attraction of the two mass plates. The total field acting on us was small, but we had to be careful not to forget it. If we lost contact with the ships, the nearest landing point was back on Oberon Station, thirty billion miles away.

Nina in the flesh was even more impressive than she was over the videolink, but I gave her little more than a cursory once-over. McAndrew's color was bad and even while I was cracking my suit open and hustling out of it I could hear a frightening bubbling sound in his breathing. Thank God I had learned how to work in zero gee—required part of any space medicine course. I leaned over him, vaguely aware of the two others intently watching. The robodoc beside me was clucking and flashing busily, muttering a faint complaint at McAndrew's condition and the zero-gee working environment. Standard diagnosis conditions called for at least a partial gravity field.

I took the preliminary diagnosis and prepared to act on it even while the doc was still making up its mind. Five cc's of cerebral stimulant, five cc's of metabolic depressant, and a reduction in cabin pressure. It should bring Mac up to consciousness, if his brain was still in working order. I worried about a cerebral hemorrage, the quiet and deadly by-product of super-high gees. Ten minutes and I would know one way or the other.

I turned to Wenig and Nina who were still watching the robodoc's silent body trace. "I don't know how he is yet. We may need emergency treatment facilities ready for us as soon as we get back to the system. Can you go over to *Dotterel*, cut the drive and try and make contact with Oberon Station? By the time you have the connection we should have the diagnosis here."

I watched them leave the ship, saw how carefully Wenig helped Nina to the transfer, and then I heard the first faint noise behind me. It was a sigh, with a little mutter of protest behind it. The most wonderful sound I ever heard in my life. I glanced over at the doc. Concussion—not too bad—and a little more bleeding than I wanted to see from the left lung. Hell, that was nothing. I could patch the lung myself, maybe even start the feedback regeneration for it. I felt a big grin of delight spreading like a heat wave over my face.

"Take it easy, Mac. You're doing all right, just don't try and rush yourself. We've got lots of time." I secured his left arm so that he couldn't disturb the rib cage on that side. He groaned.

"Doing fine, am I?" He suddenly opened his eyes and stared up at me. "Holy water, Jeanie, that's just like a medic. I'm in agony, and you say it's a little discomfort. How's Nina doing?"

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Jay Kay Klein's

BIOLOG

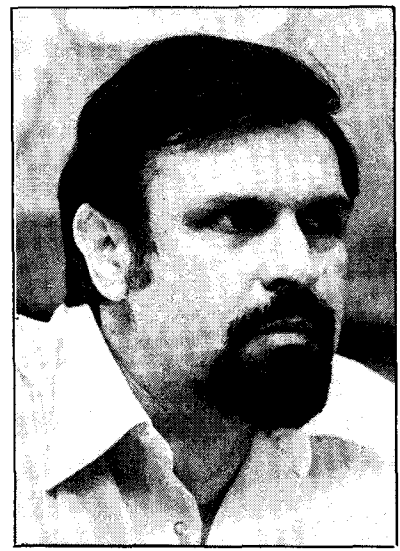
Charles Sheffield claims he has no idea why he suddenly took up science fiction writing in 1976. He says that he had no previous record or desire for writing fiction of any kind. If theorizing may be permitted, it is just possible this came as an unconscious reaction of a keen, imaginative mind following some fifteen years of writing scientific papers of the most abstruse kind, with titles to match: "High-Order Predictor-Corrector Methods in Orbit Computation," "Bi-diagonalization of a Triangular Matrix," and "Linearized Solutions for a Circular Orbit Perturbed by Tesseral Harmonics," to cite a few.

He is spectacularly representative of an always significant number of practitioners of the art of science fiction writing, the scientific boffin who has a life-long love of the field. Charles started reading science fiction when fourteen, still reads it, and swears he will read it to his dying day. Since his first story in a 1977 magazine, and a first Analog appearance a year later, he has published about thirty short stories, a short story collection, and two novels. Five more novels are either finished or nearing completion.

To put this accomplishment in perspective, it should be realized that Charles writes only an hour or two at a time. His current duties as vice president of R and D with the Earth Satellite Corporation are highly demanding, and he is also the president of the American Astronautical Society.

Charles now lives in Washington, D.C. Born in England, he received B.A. and M.A. degrees in mathematics from St. John's College, Cambridge, followed by a Ph.D. in theroretical physics. His thesis subject was "Algebraically Special Place-Times in Problems of General Relativity and Gravitation."

In *The Web Between the Worlds* (ACE Science Fiction, 1979), Charles makes full use of his theoretical and practical knowledge of space flight to center on the novel concept of an orbital tower reaching thousands of miles upwards from the equator. In an amazing coincidence, reminiscent of Darwin and Wallace, another English boffin and science fiction writer, Arthur C. Clarke, the same year also centered a book around this idea. If nothing else, this happenstance shows that Charles is playing in the same league with the best science fiction has to offer.



Charles Sheffield

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"Not a mark on her. She's not like you, Mac, an old bag of bones. You're getting too old for that sort of crap."

"Where is she?"

"Over on *Dotterel*, with Wenig. What's the matter, still infatuated?"

He managed a faint smile. "Ah, none of that now. We were locked up on *Merganser* for more than two weeks, in a three-meter living sphere. Show me an infatuation, and I'll show you a cure for it."

The com-link behind me was buzzing. I cut it in, so that we could see Wenig's worried face.

"All right here," I said, before he had time to worry any more. "We'll be able to take our time going back. How are you? Got enough water?"

He nodded. "I took some of your reserve supply to make up for what we threw at you. What should we do now?"

"Head on back. Tell Nina that Mac's all right, and say we'll see you both back at the Institute."

He nodded again, then leaned closer to the screen and spoke with a curious intensity. "We don't want to run the risk of having a stuck life capsule again. I'd better keep us down to less than ten-gee acceleration."

And he cut off communication, without another word. I turned to McAndrew.

"How high an acceleration before you'd run into trouble with these ships?"

He was staring at the blank screen, a confused look on his thin face. "At least forty gees. What the devil's got into Wenig? And what the hell are you laughing at, you silly bitch?"

I came over to him and took his right hand in mine. "To each his own, Mac. I wondered why Wenig was so keen to get here. He wants his shot at Nina—out here, where nobody else can compete. What did *you* tell her—some sweet talk about her lovely eyes?"

He closed his eyes again and smiled a secret smile. "Ah, come on Jeanie. Are you telling me you've been on your best behavior since I last saw you? I'm not soft on Nina now."

"I'll see." I went across to the drive and moved us up to forty gees. "Wait until the crew on Titan hear about all this. You'll lose your reputation."

He sighed. "All right. I'll play the game. What's the price of silence?"

"How long would it take a ship like this to get out to Alpha Centauri?"

"You'd not want this one. We'll have the next one up to a hundred gees. Forty-four ship days would get you there, standing start to standing finish."

I nodded, came back to his side and held his hand again. "Mac, that's my price. I want one of the tickets."

He groaned again, just a bit. I knew from the dose the doc had put into him that it wasn't a headache this time. ■

● We believe that when men reach beyond this planet, they should leave their natural differences behind them.

JOHN F. KENNEDY

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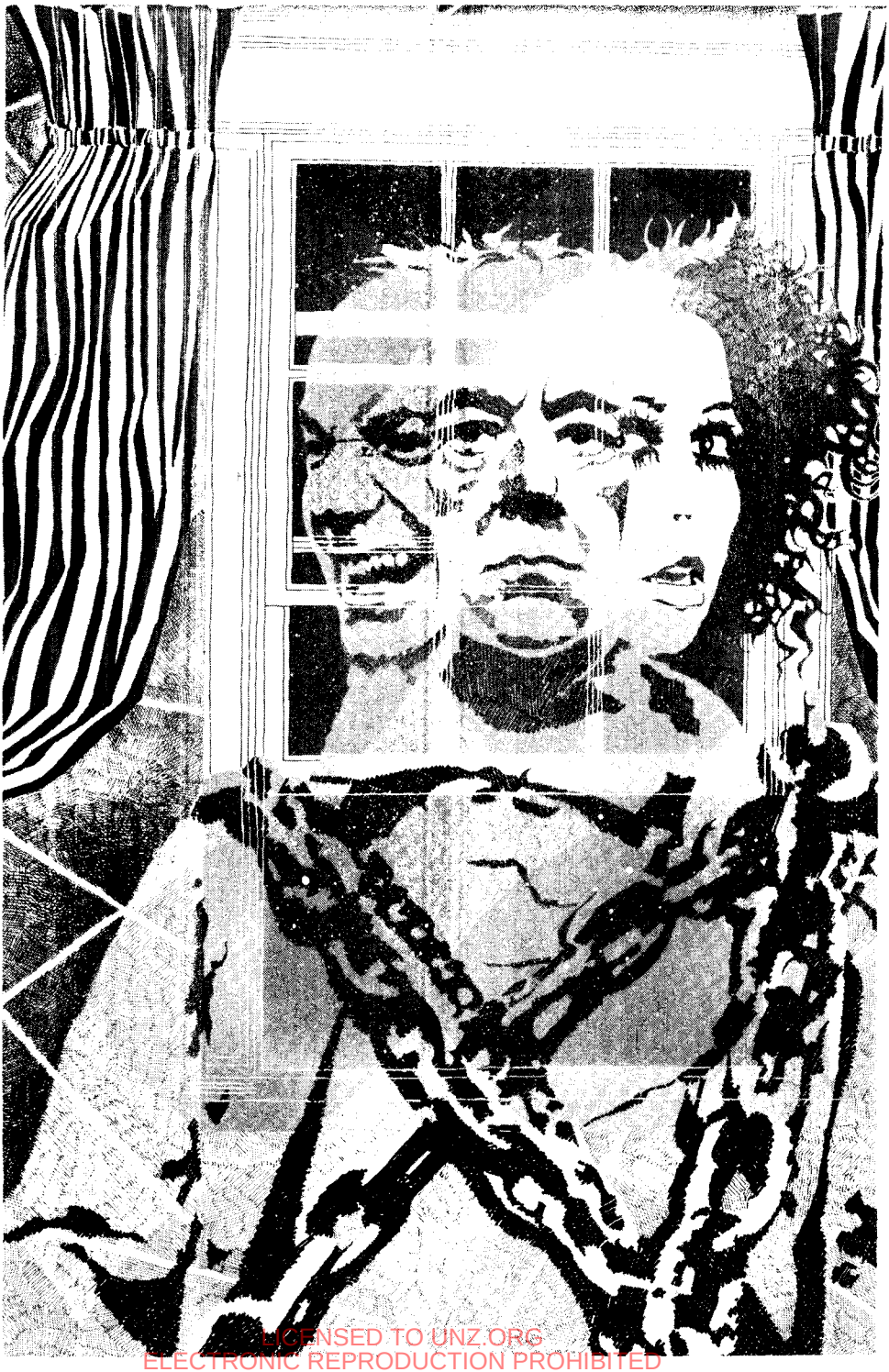

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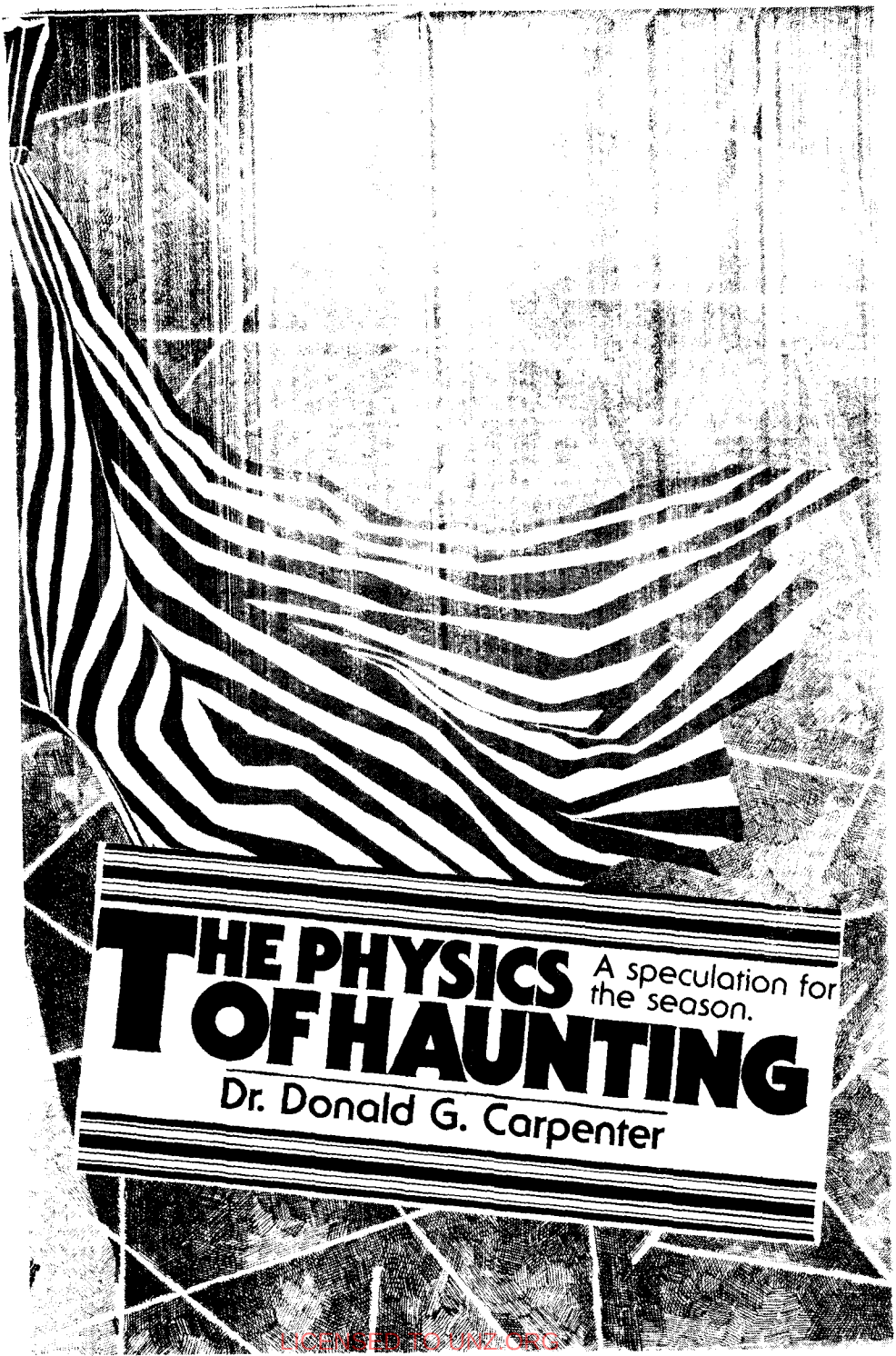

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"I once saw a ghost!" you say with a shiver. Immediately you are the center of attention. However, two members of the group—the physicist and the astronomer—turn away in disgust and darken your doorstep nevermore.

That overly-emotional reaction of rejection (without trial by evidence) is a strange one for scientists (supposedly non-emotional beings) to have. Yet, the vast majority of scientists react in just that way when faced with situations noticeably beyond the range of present scientific knowledge and where solid experimental data is hard to acquire and is often conflicting. Human experience is rife with situations provoking such insecure behavior: UFO's; ball lightning (until the 1940s, *kugelblitz* was considered to be only an illusion); meteorites (the French Academy of Science once violently declared it impossible for rocks to fall from the air); and many others. Sometimes the subject area is indeed one of misconceptions, lies, frauds, mental illness and the ilk but often as not there is an entirely new field of scientific investigation just waiting to be probed fruitfully. It is now beginning to appear as if the subject of ghosts may fall in that latter category.

In many respects the problem is similar to that of the UFOs. How do you measure the parameters of a fleeting phenomenon the nature of which is ill-understood, and which may actually be a collection of many different natures? The answer is: if possible, you isolate one nature at a time, and identify the temporal and physical location of some future events before they occur. That can not yet be done for UFO's but, fortunately, it may be able to be done for at least one type of ghost/entity.

To isolate the type of ghost/entity of interest, let's make some intuitive yet simple assumptions. Let's assume:

1. All known physical laws apply (no magic allowed).
2. The standard nighttime ghost, the poltergeist, and the soul are all different manifestations of the same entity. (There may be ghosts that are not souls, and there may be souls that are not ghosts. The only type of ghost in which we are interested here is that which *is* a soul.)
3. Each ghost/entity has essentially the same fundamental characteristics as every other ghost/entity of the same type.
4. At any given instant the ghost occupies a limited volume of 0.07 cubic meters (the approximate volume of a 70 kilogram human).

Now let us find out whether or not we have assumed our way into a null class.

STANDARD NIGHTTIME GHOST

Because there are many different types of entities which supposedly haunt at night (*e.g.* banshees, spectres, bogies, etc), we must define our standard nighttime ghost. We shall select for our consideration a ghost (often seen at night) which has a time duration of appearance lasting from a few seconds to 10 minutes or more. The shorter time period appearances are the most frequent but I have been unable to obtain

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enough accurate reports to determine whether the frequency of appearance (f) versus time duration of the appearance (Δt) actually conforms to Boltzmann statistics ($f=f_0e-\Delta^t$). **Brightness.** seems to lie in the power range of 1 to 20 watts (estimated by author). That ghost sometimes has a shrouded, sheet-like, wispy appearance, and is always whitish in color (occasionally with a pale bluish or greenish tint added, while more rarely even a faint trace of red is reported). The apparition is often transparent and, generally, seems to be slightly smaller than the average person. The ghost is usually facing the viewer(s); if an additional viewer is to the side, that viewer sees the side of the ghost. The ghost is usually human in appearance, with rare appearances as an animal. People report a cold, clammy feeling often associated with the apparition (most often occurring before *and* during the sighting). And, when sounds and/or smells are evident, they are muffled, weak, and indistinct. Moaning is the most frequent sound although rattling chains, shrieks, and laughter are also reported, as well as occasional clear and distinct words.

When a startled viewer "sees" that standard nighttime ghost, what is actually transpiring? Other than psychological or psychiatric possibilities (which we shall ignore), there are three straightforward likelihoods—two internal to the viewer's body and one external. Firstly, the ghost might be directly affecting the electrical/chemical processes in optical nerves, causing the viewer to "see" it. The ghost also might be accomplishing the same end by directly affecting the visual center in the viewer's brain. Or, lastly, the ghost could be causing photons to be emitted from its immediate vicinity, and the viewer could be seeing the ghost as one sees an image on a TV screen. Because the same ghost is sometimes seen by many widely-spread viewers at the same time, and because the aspect of the features seen by the collection of viewers simultaneously depends upon the angle of viewing, the photon-emission hypothesis appears to be valid (whether or not the other processes also occur on occasion).

So what we evidently are discussing is an entity that causes photons to be emitted while the entity is somehow suspended in air. As air (nitrogen, oxygen, water vapor, etc.) is frequently the only material in the ghost's immediate vicinity, and Assumption 1 (no magic) pertains, the conclusion is obvious—the photons displaying the ghost come from transitions within the electronic structure of air molecules and atoms. That suggests a similarity to Earth's own shifting aurora; but this similarity is probably only superficial.

For the shimmering planetary aurora, after the atoms and molecules are raised to excited states, the colors of the photons emitted in the rarified air depend upon the mean lifetime of each excited state involved. For example, the mean lifetimes for the violet and blue transitions of the di-atomic nitrogen ion are approximately 10 nanoseconds (10^{-8} seconds). Thus, the violet and blue photons can be emitted before the ion de-excites thermally thru collision. On the

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other hand, one of the two metastable states of monatomic oxygen has a mean lifetime of 110 seconds, so it de-excites by collision long before its red photons can be emitted in noticeable amounts. The other metastable state of monatomic oxygen has a mean lifetime of 0.7 seconds, and emits green photons. There are several metastable states of neutral di-atomic nitrogen in the red regime but their mean lifetimes discriminate against much red emission.

Thus, near the surface of the Earth, a ghost using the dense air to emit photons in a manner similar to the aurora would be limited by the known laws of atomic and molecular physics (and the four modes possible of atomic de-excitation) to primarily the colors blue (= 4,400 Å; = 4,600 Å to 4,800 Å) and violet (= 3,950 Å), with a rare tint of green (5,577 Å)and a doubtful touch of red.

However, it is likely that, rather than conforming to the auroral emission pattern, the photonic spectrum conforms to the electric spark emission pattern as displayed in the *Handbook of Chemistry and Physics* for each of the atmospheric gases. The ghost would then appear whitish in color, with rare tints of blue, green, or other colors. In addition, the radiance level is so low (1 to 20 watts from a volume of 0.07 cubic meters) that the human eye may well see the ghost with night vision (rods instead of cones) and thus be color-blind. Therefore, whether the emission conforms to an auroral spectrum (primarily bluish), an electric spark spectrum (primarily whitish) or some other pattern, the living viewer probably sees it in black and white.

Ah, you ask, but from where does the ghost get the energy to excite the air? Does it use some of its own energy or does it access another source? And, if it uses its own energy, how does it replace that energy (assuming that it does)?

Perhaps those questions should have been posed to the great English scientist James Clerk Maxwell because one possibility is that the high energy "tail" of the Maxwell-Boltzmann thermal distribution of air molecules is accessed in some manner to excite thermally the molecules of air (converting some to ions and raising the energy levels of the bound electrons). The ghost may well go Maxwell's "demon" one better; instead of separating air into hot and cold components, it evidently succeeds in converting thermal energy to photonic at a rate of 1 to 20 watts (when visible). That could cause the thermal energy of the air to decrease sharply.

The greatest temperature drop (felt by observers) should thus occur in the immediate vicinity of the ghost. Interestingly enough, if there were no convection or conduction, a strongly emitting ghost (20 watts) drawing upon the thermal energy of the air should cause sea-level air to drop in temperature at approximately 14.5 degrees Celsius per minute during the appearance until the dew point is reached. Upon reaching the dew point, the cooling air would shroud the ghost in white fog. However, because convection and conduction do normally occur, near the ghost (shrouded

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or not) the air should feel cool and damp ("cold and clammy"), and the rate of temperature drop where the ghost is located should be less than the maximum 14.5 degrees Celsius calculated.

An obvious conclusion is that areas where the dew point is high (Ireland, Scotland, England, etc.) should have more "shrouded" ghosts than would dry climates. Fog reflects whatever color light impinges upon it, and that too may account for the occasional reports of ghost colors other than white.

Because production of moans and other sounds requires energy also, temperature-drops would be expected in those non-visual cases too. Where the dew point is high, a wisp of fog or a "white-shrouded figure" without features should sometimes accompany the sounds.

Thus, the nighttime ghost phenomena obey the laws of physics quite accurately. That seems very obliging of what has been regarded heretofore as a purely "psychic" or "hysteric" event.

There is something of even greater interest though to be learned from the foregoing: the evidence suggests that the nighttime ghost manipulates energy, Assumption 1 therefore requires that the ghost itself be composed of either energy or energy and matter. (To manipulate energy requires the application of energy.) Furthermore, despite many observations of nighttime ghosts, and many attempts to detect the "essence" of the ghost, no one has reported the slightest evidence of the ghost being composed of matter. Thus, the ghost is most likely composed entirely of energy, the nature of which is not addressed here. But, because of Albert Einstein's relativistic law of mass-equivalence, the energy of which the ghost is composed must have a mass-equivalent and thus be detectable by gravitational methods.

We still do not know the magnitude of the effect for which we are looking, nor do we know when or where to perform the search, yet we have deduced something quite important: the entity that creates the nighttime ghost phenomena is plausible, and composed entirely of energy.

POLTERGEIST

The poltergeist is a mischievious ghost or spirit which manifests its presence by violence. The violence may be in the form of sharp knocks on wood or other surfaces, the springing of locks on doors, or the flinging of objects (including knives). There is a tendency for the poltergeist phenomena to occur in the vicinity of teenagers . . . particularly teenage girls. It's rather reminiscent of a pubescent boy trying to get a young girl's attention.

The method in which the poltergeist expends its energy differs from that of the nighttime ghost in two ways. First, the energy is expended in impulses, each of which has a time duration far less than 1 second in length. (A cracked window, a flung knife and a sharp rap are each indicative of separate impulses of expended energy.) Second, the amount of energy involved in each impulse is almost miniscule compared to the energy (up to 12,000 joules) manipulated

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in a 10 minute demonstration by a nighttime ghost. The maximum impulse delivered by the poltergeist seems to occur in the tipping over of bureaus or chests of drawers weighing as much as approximately 50 kilograms. (The center of gravity rises perhaps one-eighth of a meter during the tipping.) The energy expended in such a maximum impulse is in the neighborhood of 60 joules but certainly no less than 30 joules and probably no more than 120 joules.

The significance of the short time-duration of each impulse is that the peak power output must be large, perhaps 6,000 watts or more. That implies that, unlike the nighttime ghost who seems to draw (as needed) upon the thermal energy of its immediate locale, the poltergeist stores up temporarily the energy which it expends so abruptly and violently. And the fact that the poltergeist usually generates several impulses during each session of haunting suggests that the 60 joules or so stored and expended in each impulse may be only a small fraction of the entity's total energy resources.

No temperature drop is noted before, during or after a poltergeist session but this is hardly surprising. The air in the immediate vicinity of the poltergeist would drop at most one and a half degrees Celsius prior to each impulse. The poltergeist apparently moves around between impulses (different locations in the same room, different rooms and even different floors) distributing the cooling effect through a large volume of air; the temperature drop would be small enough to escape notice—even *if* the thermal energy of the air were the energy source from which the poltergeist draws.

However, the storing and expending of energy by the poltergeist permits us to make a guesstimate of the size of its essence—its mass-equivalent/total-energy. For want of a better idea, let's assume that the work involved in one impulse of violence is the same *fraction* of the poltergeist's total (body?) energy as the work accomplished in a 10-hour day was of a 70 kilogram (weight: 686 newtons) stevedore's total mass-energy. (You might look upon it as the work accomplished between major periods of rest, or between major replenishments of energy through consumption of food/drink/whatever.) As an estimate, the stevedore of yesteryear might have moved 300 sacks per hour (one sack per 10 seconds, 50 minutes per hour) where each sack's mass was 25 kilograms (245 newtons) and the stevedore raised it one-half of a meter (total work accomplished per day: 3.68×10^5 joules). Therefore, by proportionality, the poltergeist's essence is 60 joules times 70 kilograms divided by 3.68×10^5 joules equals 11.4 grams (between 5.7 and 22.8 grams). Assumptions 2 and 3 apply here. They hold that all standard nighttime ghosts/poltergeists/souls should have a mass-equivalent of between 5.7 and 22.8 grams. However, our assumptions do not actually justify a conclusion in terms of two or more significant figures. Therefore, those limits can become 6 and 20 grams.

Using Einstein's relationship $E = mc^2$, the total energy of the poltergeist's

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essence can be estimated. However, I am more interested in the mass-equivalent of the energy. There are ways to detect/measure a ghost/soul with a mass-equivalent that large.

LIMITS ON THE MASS-EQUIVALENT OF THE HUMAN SOUL

If one were to suggest a lower limit on the soul's mass-equivalent, a very tentative 6 grams might be offered. We could set the upper limit at approximately 20 grams but perhaps there is a way to establish a more accurate upper limit.

The most precise way to measure a quantity of energy is often as a quantum in transition. In this case, that means measuring the total energy of the human soul as it enters or leaves the human body. And, because the mass-equivalent of that soul energy must respond to gravity (Assumption 1), the weight of the human body must decrease sharply (perhaps even as a step function) at the time of death.

According to Assumption 3, the energy content of a baby's soul is essentially equal to the energy content of an adult's soul, and to that of a spirit. Observations of babies at time of death therefore put a crude upper limit on the mass-equivalent of the energy content of the soul. Despite the suspected sharp decrease in the weight of each baby at the time of death, no observers have commented that the bed surface rises slightly. That means the weight of the soul probably does not exceed 1 percent of the dying child's weight. Recognizing that normal newborn babies weigh as little as 5 pounds (22.2 newtons, or a mass of 2.27 kilograms), each baby's soul must have a mass-equivalent which probably does not exceed 22.7 grams.

The soul's mass-equivalent is therefore something between 6 and 22.7 grams. Again, our assumptions do not actually justify an answer in terms of two or more significant figures. Thus, we shall select 20 grams as the soul-based upper limit of mass-equivalent. It's rather interesting that the poltergeist-based upper limit is also approximately 20 grams.

DISCUSSION

From the study of the standard nighttime ghost, we have deduced that the human soul is probably composed of energy; Einstein's research on relativity reveals that the soul's energy has a mass-equivalent which may be detected and measured by mass/gravitational methods. From the poltergeist, we have deduced that the soul's mass-equivalent may exceed 6 grams. And from both human deaths and the poltergeist, we have estimated the upper limit in the area of 20 grams.

It might be appropriate at this time for an experiment to be designed and carried out using 1,000 or more terminally-ill and/or elderly volunteers. A continuous record of each of their weights would then be made automatically by very sensitive equipment as they transitioned from life into death. An extensive, detailed listing of each volunteer's characteristics during life should also be made (date of birth, height, nation of origin, race, IQ,

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"goodness", sense of humor, profession, religion, etc.) for possible later correlation with the weight measured for each soul.

If positive results are obtained, and then confirmed by other researchers, a wide range of additional experiments could be attempted:

1. What are the vector directions and location of emission of the soul from the dying human's body?
2. When does the soul enter the fetus—at birth, or at some other specific time prior to birth? (It would be nice for a change to have legal and religious decisions, such as those regarding abortions, made on rational grounds.)
3. Do animals have souls?
4. Do souls behave in accordance with Bose-Einstein, Fermi-Dirac or some other statistics? This would lead to more sophisticated concepts and experiments such as: Do souls have "spin?" What are the forces between souls? Are souls stable or do they "decay" into other entities? Can souls unite/merge? If yes, is the result a single, larger soul or something else?
5. Do souls change in magnitude of energy with experience?
6. How many souls can occupy a single, incarnate body at the same time?
7. How are ghosts/poltergeists/souls affected by radiation (including thermal) and by passage through matter??

Question 3, regarding possible animal souls, is particularly interesting in light of such books as *The Amityville Horror* in which a ghostly pig supposedly caused great trouble and fear. If pigs really do have souls, it would be understandable that they might tend to be unkind to the type of beings that kill and eat them. It would also help explain why "demons" often are reported as appearing in non-human form.

Experimental proof of the soul's existance, verification of some religious beliefs and refutation of others, discovery of physical laws controlling the behavior of souls, learning more about the true nature of souls—all these things may be possible for those willing to look and to investigate with honest, open and logical minds. But resistance is guaranteed from the insecure, the small-minded, and those who benefit from the status quo.

The key to opening this Pandora's box of possibilities lies in employing an organization with impeccable reputation and creative vision to perform the initial 'proof of principle' experiment. This honorable and intelligent group must weigh the human soul in a clear and incontestable manner, and must report the results openly to the world. If no soul is detected despite many measurements, the matter would unfortunately remain unresolved because the guesstimated minimum mass-equivalent of 6 grams is shaky at best; the soul (if one exists as we have defined it) may actually mass much less than that. On the other hand, actual detection and

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measurement of the soul would have a great impact on the peoples of our world.

Who would benefit from that impact? Certainly, national governments will avoid the situation as if it were contagious leprosy. (In-power politicians usually fear dramatic change.) However, experimental proof of the soul's existence would be of great value to organized religion in its struggle against agnosticism and atheism. The real question thus becomes: which religious organization has the courage of its beliefs, and the resources to underwrite the experiment? Some such organizations will perhaps insist that such an experiment is irreligious and unnecessary because 'every true believer' already knows the answer.

I suspect that individual citizens performing such experiments will encounter all kinds of prejudice and opposition. And, if they succeed despite that, their results will probably be ignored. So, how about it, you Catholics, you Jews, you Moslems, and you Protestants. Do you have the courage to really test what you claim to believe? And do your priests, rabbis, mullahs, and ministers have the open-mindedness to check on one of the fundamental tenets of their religions—the existence of the human soul?

EXPERIMENTAL EQUIPMENT

To detect the presence, and/or measure some aspect, of an ephemeral entity whose mass-equivalent lies between 6 and 20 grams, very sensitive and rapid-response equipment is required. Some useful equipment would be:

a. Light-amplifier camera and film capable of recording (in color) light sources as weak and fleeting as Earth's aurora. (Ghosts.)
b. Microphone, amplifier and tape recorder capable of recording details of sound from a one-tenth watt source 15 meters distant. (Ghosts, poltergeists and souls.)
c. Scales capable of supporting 400 kilograms while discriminating a fraction as small as 10^{-7} of the total weight. Automated. (Souls.)
d. Thermometer — deci-degree Celsius. Remote-reading, mobile, rapid-response. (Ghosts.)

Because the nature of the energy composing the entity is unknown, past failures of magnetometers and electric field detection equipment to yield postive results is not surprising.

ADDITIONAL NOTE

Since originally completing the foregoing, I have been informed by a friend that an experiment such as I suggest was performed in the 18th Century. The result was negative. Unfortunately, my friend has been able to recall neither the source of his information nor the details of the experiment. Even if he could recall all, however, the result would still be suspect. It is doubtful that the 18th Century experimental equipment was capable of discriminating as small a fraction as 10^{-4} of the total weight involved; thus it was most likely insufficiently sensitive to detect the soul. ■

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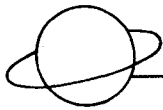
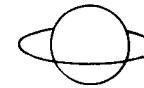


GALAXY FORMATION

Dr. John Gribbin



Just when we thought we were beginning to understand galaxies, new data suggests that we're going to have to change our ideas quite a bit.

When we look at the night sky on a cloudless night (and away from the bright city lights!) we see an impressive display of bright stars. The display is so impressive, indeed, that it comes as something of a surprise to learn that only about 3,000 stars can be distinguished by the unaided human eye even on the darkest moonless night. No matter how long you spend looking at the sky you will never see the fainter stars, since the human eye adapts, as far as it is able, to the dark conditions very quickly.

But a photographic plate will continue to build up an image as long as it is exposed, and every photon that strikes the plate helps to make the image stronger. So it is through astronomical photography that astronomers learnt of the great number of very faint stars in the sky, and also of the great numbers of faint, fuzzy "nebulae," quite different from stars.

These identifications were only made in the 1920s, when the first generation of great telescopes built high on California mountains came into use; before then, although some fuzzy nebulae had been identified, nobody really knew what they were. Now, the picture of our universe seems clear—there are thousands of millions of stars making up an island in space some 30 kiloparsecs (100,000 light-years) across, our galaxy.

Roughly speaking, these stars are similar objects to our sun, although there is a great range of stellar masses and brightness. The fuzzy blobs, we now know, are whole galaxies of stars in their own right, each containing hundreds or thousands of millions of stars. It is galaxies—even clusters of galaxies—rather than individual stars which make up the fundamental "building blocks" of the universe, and the origin and evolution of galaxies has

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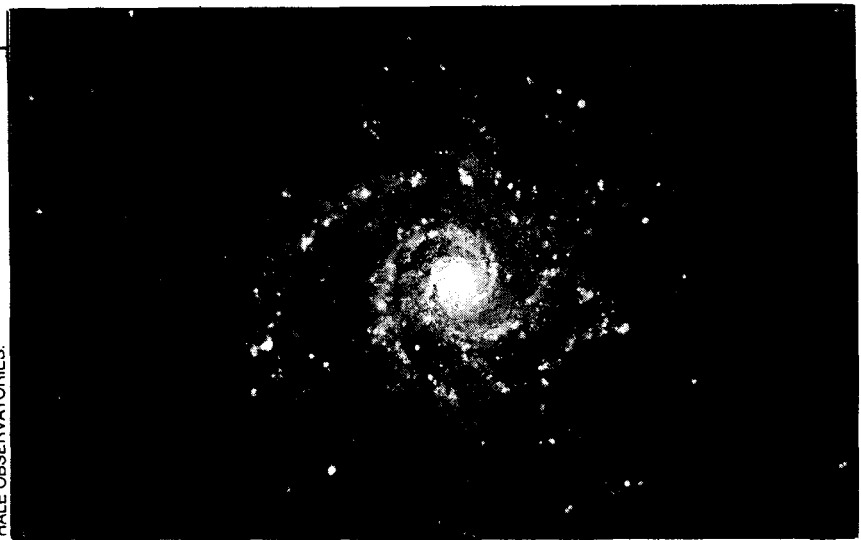

HALE OBSERVATORIES.

1. A typical spiral galaxy: NGC 628 (or M74) in Pisces.

been a mystery ever since they were first identified in the 1920s.

It was only in the late 1970s, following a revolution in cosmological understanding over the previous 10 or 15 years, that a satisfactory understanding of galaxy formation emerged—and this is of more than passing interest, since presumably our own galaxy (usually referred to with the capital, our Galaxy) formed in the same way as all the others. By getting an understanding of galaxy formation, the cosmologists are coming to grips with our own origins.

It was from the study of fuzzy blobs on photographic plates that Edwin Hubble and his contemporaries first produced evidence, half a century ago, that the universe is expanding. The optical spectra of distant galaxies show the redshift which indicates a recession velocity, and if everything is flying apart now, then presumably everything was more tightly packed long ago, and the universe was born in an outward explosion from a very compact state, the Big Bang. Since the 1930s, in spite of the desperate attempts of some cosmologists to get round this requirement of a definite origin to the universe, the evidence has continued to mount in favor of the Big Bang idea; today scarcely any mainstream cosmologist disputes this interpretation of the evidence. Over the same decades, our understanding of galaxies improved—but the details of their origin within the framework of an expanding Big Bang Universe remained mysterious.

It didn't take long for galaxies to be classified into two main types, spirals and ellipticals. As the name suggests, spiral galaxies (like our own) are flattened, disclike systems in which the bright stars trace out a spiral pattern,

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while ellipticals are cigar shaped and show no trace of spiral structure. Many astronomers have added to this simple classification by identifying different categories of spiral or elliptical galaxies, different sub-categories, and so on. But this kind of nit-picking attention to detail—sometimes referred to as "astronomical stamp collecting"—hasn't helped to solve the mystery of where the galaxies came from, or why they come in two main varieties.

Astrophysicists could talk in general terms about huge clouds of gas collapsing in space and fragmenting into smaller blobs which themselves collapsed to form stars, but the specific details just couldn't be made to work satisfactorily. To start with, the existence of the huge gas clouds had to be pulled out of a hat—leaving the problem of where huge clouds of gas came from in an expanding universe. And then the rather simple equations which describe the collapse and fragmentation of large gas clouds under the influence of gravity show quite clearly that it takes much longer for such a cloud to turn into anything like a galaxy than the total time that has elapsed since the Big Bang. (The age of the universe is known, accurately enough for these purposes, from the measured rate with which galaxies are flying apart today.) Any satisfactory theory of galaxy formation had to take account of the Big Bang itself, and of the evidence that "only" some 15 thousand million years have elapsed since the Big Bang. The problem remained intractable until the mid-1960s, when the seeds of the present revolution in our understanding of galaxies were sown by a new observational discovery—but before that could happen, it took ten years to sort out the revolutionary implications of the discovery for our understanding of the Big Bang.

This discovery, perhaps the single most important piece of observational evidence in the whole of astronomy, was of the so-called "cosmic background radiation." The discoverers, Arno Penzias and Robert Wilson, of the Bell Labs, received a Nobel Prize for their work in 1978; but by then modern cosmology had long since been transformed by the revolution their discovery triggered. The background radiation, at an effective black body temperature of just under 3°K, bathes the entire universe and is interpreted as the last remnant of the hot fireball of the Big Bang itself. It wasn't so much the new observations themselves which transformed cosmology in the mid-1960s, but the shock which the discovery gave to cosmologists. For thirty years they had formed an exclusive and rather esoteric priesthood, arguing about the subtleties of their interpretation of Einstein's equations in a manner sometimes reminiscent of theological debate about the number of angels that could dance on a pinhead. By the mid-1960s, the consensus in favor of the Big Bang theory had emerged, but it came from the head, not from the heart. The discovery of radiation directly traceable to the Big Bang made cosmology an observational science, and produced a gut shock to cosmologists. For the first time they began to see the equations they scrib-

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bled on their blackboards not as abstract solutions to interesting mathematical equations, but as a real description of the real universe.

Cosmology has never been the same since, and fired with this new gut feeling for what they were doing it took only a few years for the one piece of new observational evidence, the faint hiss of radio noise in the background radiation, to provide the key to an understanding of the earliest period of the Big Bang itself, the cosmic fireball described so graphically by Steven Weinberg (another Nobel Prize winner) in his book *The First Three Minutes*.

By taking the temperature of the Big Bang, and using their new found belief in the validity of the Big Bang concept to apply knowledge about the behavior of matter and energy at high temperatures and densities to the origin of the universe itself, cosmologists came up with their present understanding of how a hot fireball of energy—essentially all radiation—cooled off and produced a maelstrom of particles, created out of the energetic radiation in line with the familiar equation $E = mc^2$. The mixture of particles and radiation bursting out from the Big Bang continued to cool, until today the "temperature of the universe" is the tiny 3°K of the remaining background radiation. Radiation dominated the fireball for the equivalent of 700,000 years (compare this with the 15,000-million-year age of the universe), by which time it had cooled sufficiently (to about 5,000°K) to allow positively charged protons and negatively charged electrons to get together to form electrically neutral atoms of hydrogen. (Some helium was also made in the Big Bang, but the principle is the same—radiation can only interact with *charged* particles—and once neutral atoms were made, radiation and matter "decoupled" and went their separate ways, the radiation fading to the whisper discovered by Penzias and Wilson, the matter ultimately to form stars and galaxies.

By the mid-1970s, theorists had reached a curious position. They could explain the first 700,000 years of the life of the universe, in great detail, starting out from a hot Big Bang and ending up with a sea of matter and radiation on the verge of decoupling. They could also explain the behavior of the universe observed today, with clusters of galaxies flying apart from one another. But they still could not explain how galaxies had formed, somewhere in the middle of this time span. The resolution of the puzzle came as the theorists turned their attention to the details of just what was happening in the fireball at the crucial time when matter and radiation were just on the edge of decoupling, as the swarming protons and electrons settled into stable atoms. The "new-look" cosmology had to be developed first, before the next stage of the problem could be tackled; and, happily, over the same decade that the new-look cosmology was being refined, improved observations of the distribution of distant galaxies were being made, and ever faster computers were providing ever more detailed statistical analyses of how clusters of galaxies, and clusters of clusters,

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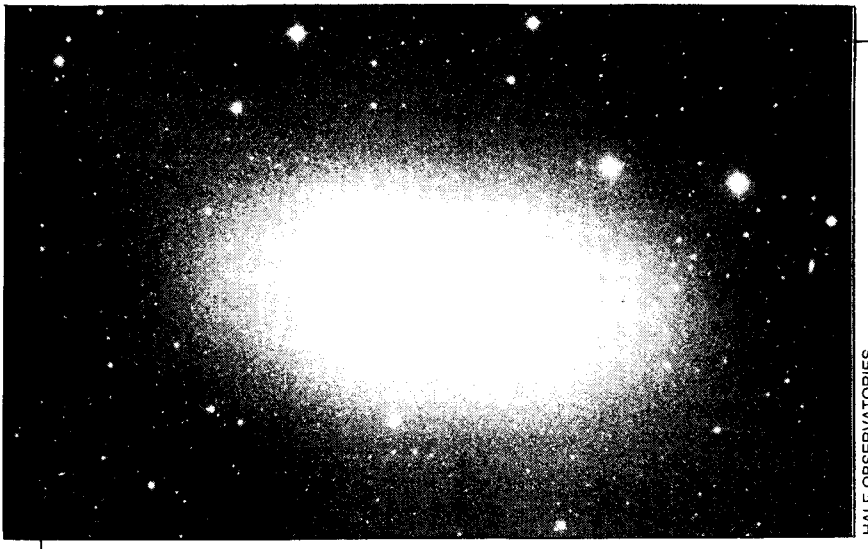

HALE OBSERVATORIES.

2. A typical elliptical galaxy: NGC 205 in Andromeda.

group together in space. This new observational evidence combined, in the late 1970s, with the theoretical progress to produce the first satisfactory model of galaxy formation.

The major landmark, which will surely be remembered as one of the key scientific papers of our time, was a paper by Martin Rees and Simon White, of the Institute of Astronomy in Cambridge, which appeared in the *Monthly Notices of the Royal Astronomical Society* in 1978 and offered a crystallization of many of the new ideas. Perhaps the most dramatic feature of the new picture is that the bright galaxies—those fuzzy blobs on photographic plates—turn out to be no more than the tip of the astronomical iceberg. All the evidence suggests that every galaxy, including our own, is surrounded by 10 times as much matter in the form of dark stars scattered over a halo perhaps 20 times as far across as the bright galaxy.

The activity in the universe today, all the bright stars in all the bright galaxies, is simply the last flickering remnant of a previous era of much greater activity in which these supergalaxies formed and ran through their life cycles. This rather startling displacement of man (yet again!) from near the center of the action in the universe to the fringes deserves more public attention and headlines than it has yet received—and it all stems from an understanding of the two kinds of fluctuation that can grow up in a fireball mixture of matter and radiation just before it decouples.

First, there are the so-called "isothermal" fluctuations, in which the random movement of the particles in the fireball produces a local concentration of matter, but with the radiation distribution unchanged. Then, there are the "adiabatic" fluctuations, in which

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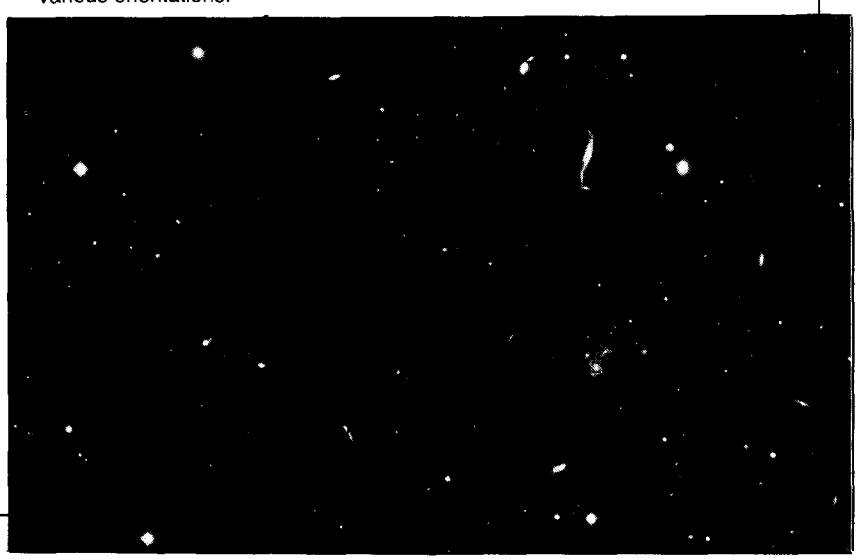
patches of increased matter density are accompanied by increased energy density, thanks to the coupling between matter and radiation. Clearly, in the maelstrom of the fireball, swirling eddies on a cosmic scale were constantly producing and destroying fluctuations of both kinds. The distribution of matter in the universe today, in the form of galaxies and clusters of galaxies, results from the last random fluctuations that were "frozen in" as matter and radiation decoupled and the universe cooled. But which kind of fluctuation dominated the fireball?

The crucial difference between the two kinds of fluctuation is that whereas isothermal fluctuations (matter only) can grow to any size, adiabatic fluctuations can survive and grow only if they start out bigger than a critical size—otherwise, the energy of the radiation damps out the fluctuation before gravity can get a grip and hold it together. If isothermal fluctuations dominated the fireball, then the universe today should be filled with clusters of galaxies of all sizes—clusters within clusters within clusters and so on, like a nesting set of Russian dolls. On the other hand, if adiabatic fluctuations dominated, then the end product would be a huge array of essentially similar clusters, side by side like a box of toy soldiers. More than a million galaxies have now been identified as members of one cluster or another, and the statistical calculations show very clearly that they fall into the hierarchical pattern expected for isothermal fireball fluctuations. So the broad outlines of the understanding of the fireball fit the observed pattern of galaxies in the universe. Another piece of observational evidence provdes the clue to just what went on immediately after recombina-

3. Cluster of galaxies in Hercules, showing several galaxies of various types and in various orientations.



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tion (after matter and radiation decoupled) to produce the stars themselves, within this hierarchical structure.

This evidence comes from measurements of how fast galaxies rotate. Since it takes a couple of hundred million years for a galaxy like our own to turn once, obviously astronomers can't make these observations simply by watching galaxies! Instead, they make use of the Doppler shift in the spectra of light from the galaxies. As well as showing the overall redshift indicating the recession velocity in the expanding universe, these spectra show more subtle variations related to the rotational velocity of the galaxy. Superbly skillful measurements enable astrophysicists to work out the rotation rates for many galaxies, and always the story is the same—the "rotation curves" cannot be explained unless there is a great deal of dark matter surrounding each galaxy, producing a dragging effect through tidal (gravitational) interactions. This is where the estimate of ten times more matter than we can see comes from—an estimate which White and Rees not only explain but which they *need* in order to explain just how galaxies formed from isothermal fireball fluctuations.

It seems there never were great clouds of cold gas in space, waiting to collapse into galaxies. Out of the fireball there emerged a lumpy and still relatively dense distribution of hot gas clouds, already clustered into the hierarchical distribution typical of the universe today. With the overall density of the universe still high, this, less than a thousand million years after the Big Band itself, was the ideal time for stars to form, and form they did, in great profusion. They may have been very small stars, scarcely bigger than the planet Jupiter, which never burned very brightly and are totally invisible across the reaches of intergalactic space. Or they may have been very massive (which seems more likely in the high density phase of the universe), burning their nuclear fuel profligately, zipping through their life cycles and exploding to leave behind dark remnants—neutron stars or black holes—equally invisible to us today. Only after all this activity had finished, and with galaxy clusters already moving well apart from one another as the universe expanded, did a last trickle of gas fall into the middle of each supergalaxy, gathering at the bottom of the "gravitational well" and igniting a mere few thousand million stars into a secondary blaze of light. These are the galaxies we know today from astronomical photography.

This understanding of the dominant role of heavy haloes is so new that there is no reliable textbook—let alone popularization—which can be trusted on the subject of galaxy formation. The theorists are too busy reworking their ideas to have time to write textbooks yet. But the implications of the new understanding are spreading far and wide as theorists publish their ideas in scientific papers and present them to international conferences. And already new triumphs for the model are unfolding. The greatest, perhaps, is in the explanation it offers for some of the most bizarre "peculiar" galaxies, in the process of

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resolving at long last the puzzle of why there are two dominant forms of galaxy in the universe, spirals and ellipticals.

When a pool of gas gathers at the heart of a dead supergalaxy, it will carry with it a trace of rotation, which will be amplified by the collapse in the same way that a spinning ice skater can rotate faster by pulling the arms inward. So the natural kind of galaxy to form initially must be flattened and rotating—in other words, a spiral galaxy. The best way to explain ellipticals is by later interactions when spiral galaxies collide with one another and merge. Under the right circumstances, the computer models show, this kind of merging can cancel out the rotation effects to leave a cigar shaped elliptical galaxy, which still retains some "memory" of its origin. Because the stars in the new elliptical galaxy have come from two separate original spirals, they should form two families, each with their own pattern of orbits within the elliptical. And, once again, the same kind of spectral observations that show the rotation of galaxies confirm the presence of just this kind of anisotropy in the orbital patterns of stars within elliptical galaxies.

Of course, on many occasions spiral galaxies will be involved in collisions which are not just right to produce ellipticals, although detailed computer modelling of the tidal interactions of clusters does show that 20 percent of original spirals must be distorted by close encounters of one kind or another. And this neatly explains the bizarre array of special galaxies which fit no obvious classification—some look like smoke rings on the sky, others have jets of material streaming out from them, two spirals may be joined by a distorted spiral arm, and so on. The computer simulations show that all of these, and more, can be produced by tidal interactions between the original spirals.

So the theorists and observers together are bringing the story of the universe up to date. The dramatic new insight into galaxy formation is as significant a milestone as the realization, back in 1965, that the universe really did start with a Big Bang; and over the next 15 years we can expect to see many intriguing new developments as the true story of galaxy formation unfolds. Meanwhile, the realization that 90 percent of all the matter in the universe is already locked up in old, dead stars (or black holes), and that we are living amongst the embers of its former glory is, perhaps, enough. ■

Further Reading

Since these discoveries have overturned old (that is, pre-1975!) ideas about galaxies, there is no non-mathematical discussion of the story yet available. The above article covers some ground elaborated on in my book *Genesis*, to be published by Delacorte.

Steven Weinberg's *The First Three Minutes* is the best introduction to the fireball era of the universe, and the classic paper by Simon White and Martin Rees appeared in *Monthly Notices of the Royal Astronomical Society*, Vol. 183, p. 341, 1978. Most of the current developments are reported in short scientific papers in *Nature*.

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John Sanchez

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Steven Edward McDonald

IDEOLOGIES

1

Lovell Lindsay flew out along the axis of Alco Five, used his wing assembly to halt himself at mid-point, and hung, a dark dot equi-distant.

Ninety seconds passes.

A small explosion ripped a large hole in the hull of the big orbital processing plant, and three nearby technicians went hurtling out into vacuum along with a lot of air and a good mass of debris.

From this, one fact was frighteningly clear:

There was a terrorist on board Alco Five.

2

Lemon Tree Hayes had lived with the feeling that she had to stand to dominate her desk for so many years she would probably have missed it had some enterprising psychiatrist relieved her of it. On those rare occasions her unruly dustcloud of black hair was battled into canerows, she stood a bare-footed meter forty-seven, and, accordingly, she sometimes came on like a bulldozer, which fact was responsible for certain people referring to her as—

"Petersen, get this nose the hell out my office goddamnit, I'm workin'!"

—a solid gold bitch.

The nose in question was tele-reporter Joel Dayde, and he, in pursuit of news where he could find it, was busy trying to look inoffensive—his own nose, far from being prominent, was a sort of abashed pug. The face around it was badly frightened, reflecting Lemon's own feelings. Dayde was supposedly her responsibility, but right now, he was only in the way.

"Petersen, you half-assed candidate!"

Dayde twitched towards the open door, and Lemon sympathized. She wished he would just get out and do his job, snoop around. There was money in it for him, if he survived. If anybody survived.

She was about to yell again when Keri Santos, her number-one security assistant, came bouncing across the threshold. The woman ignored Dayde, and shoved plastic copy sheets down on Lemon's desk. Santos had avoided panic, Lemon was all too aware, by

Progress, unfortunately, does not automatically look that way to all concerned.

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plunging directly into her work. Whether she could avoid it much longer was another question—Lemon wasn't sure she could handle a hysteric.

"Demands," Santos said, shuffling the sheets. "He wants a rave and a rant, no money demands yet, and no escape route terms."

Lemon forgot Dayde for the moment. "Weird. What's the *or* side of it?"

"Or he'll do it again, maybe blow us to bits. He's got radio triggers, sequences of charges. From the preliminary details, it's half booby charges and half radio—mostly fool's foot tricks, I'd guess, on doors. Himself, he's carrying a squeeze trigger." Santos straightened, tried to shake back unshakeablely cropped blonde hair. Her pale green eyes were nervous. "We can't shoot him down—he'd open us up like a can of Coke."

Lemon skim-scanned the small sheaf of plastic flimsies, riffling them and spreading them card-fan style on her desk. "Get me a full scan of the factory, see if there really is a bunch of tricks out there. Don't touch anything, just get the locations, and check out how the things are rigged."

She scanned the sheets again as Santos left. They had worked together for years, since the first official day of operations on the orbital processor. Lemon had often been plagued with the thought that Santos should have been the boss, and she the assistant—and now, she was sure the roles should be reversed.

She looked up from the sheets again. "Petersen!" One more non-answer, and there'd be a perfect *castrato* for the choir. She imagined herself as being good at clobbering offenders.

Jeff Petersen finally appeared in the doorway, computer prints in his hands. He looked sick, and she thought he might just be the first to crack.

She said, "Get a patch to Earthside and get the Peelers processing Lindsay. I want everything tangible they have on his background, records, everything—even if society's to blame, I want to know about it. Get it on plastic, bring it in, and bring in our own files as well, got that?"

"Yes, ma'am," the thin man said, and he dashed off.

Lemon scanned the last couple of sheets. "Dayde?"

"Ms. Hayes?" He sounded surprised that she'd spoken quietly to him.

"You ever axis-flown before?" She looked up, watched the way he twitched. An Earthsider for an Earthsider, it figured. Dayde looked as though he expected to be plunged into vacuum at any moment.

"Had some lessons," he said, "on Steel Three, part of the program. I'm no Merriman, though."

Smartass, she thought. Alex Merriman had made *Guinness* by staying flightbound in axis for forty-eight hours. Nobody else had bothered to try breaking the record yet.

Dayde himself had only recently come in from U.S. Steel's number-three factory, on his tour. The factories were the cause of a complex publicity battle, and the various journalistic tours were usually part-sponsored by the commercial interests involved.

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"Aside from that," Lemon said, "you got on okay?"

He shrugged. "Not too bad. Groundside, I do a lot of sports stuff, so I didn't have much problem."

He had tried refining his accent to something approaching mid-Atlantic, she realized, and had almost succeeded, though some trace of Georgia backwoods kept slipping through. He had been a bit chilly towards her from the start, so maybe that explained it.

She kept eye contact with him as she activated her deskcom. "Get me Brasco, security, Steel Three."

"Yes ma'am."

Waiting for the patch to be made, Lemon said, "Your vid has inbuilt transmission link?"

"Sure." Dayde patted the big black pack he carried with him wherever he went. He touched a button, and two and a half meters of thick, gleaming antenna appeared. "Twenty-two hundred line, FM sound, color bandwidth, the run."

"That's all I wanted to know, thanks."

"Why?"

"Because—"

"Mr. Brasco, Steel Three, ma'am," the deskcom chirruped.

Lemon opened the circuit, and there was a rapid exchange with her opposite number at U.S. Steel Three. When she shut the deskcom off, she said, "You're *it*, Dayde. I don't think—"

"—I'll mind busting ass for the story," he said, cynicism making his voice hard. "I'm used to being used. Okay, so what's my worth, Ms. Hayes?"

Lemon settled into her chair, stretching. Stretching it, she could call herself pretty, but only when peaceful. Prettiest around the eyes, she always thought: there was that weird mix of Chinese and Teutonic blood that gave her slightly-slanting, cobalt blue eyes.

She said, "You take that vid of yours, and you fly on out there to Lindsay, and you keep that camera and mike on the mad bomber until I have you relieved, or I call time. He wants airtime privilege. In terms of the story, whatever you want, but the tapes you'll check with me first, *providing* we get out of this." She paused, watching the young man, trying to see him as a cowpuncher, and failing. "You'll stay up there until I say for you to come on down again. And Dayde, honey—" she saw him flinch at that, and was mildly pleased—"you just keep smiling and doing what he tells you, or I'll come for you myself and rip your goddamn Southern head off, watch?"

"I see it," he said. "Why me?" It frightened him, she thought. To be hanging all the way up there, with the entire world turning around him the way it appeared to when you were motionless in axis, with the threat of explosive decompression.

She sympathized, but her smile was still freezing-steel. "You, honey, go up there because you have the equipment, the training, the status, and more. And because, honey, it keeps you the hell out of my way."

3

"Dayde's going," Petersen said.

The operations center, formerly one of the fancy factory boardrooms, hummed, active. Lemon had moved her

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base here because of the extra room it allowed, but it still managed to seem crowded. Through the wide flexiglaze roof to the place, too, she could see the midpoint of axis space, and the floating black mote that was Lovell Lindsay. He was neatly aligned on the invisible line of axis, maintaining position with a bare minimum of effort. If he took an uncontrolled plunge from there, wings closed, he would splash endpoint to endpoint—by which time, his network of bombs would have ripped Alco Five wide open.

The see-through ceilings had puzzled Lemon for some time. Earthers had a tendency to let themselves be attracted by the curving view of the opposite side of the orbiting miniworld, and some of them kept staring until plunge-panic set in. Even she, after almost eight years living on Alco Five, wasn't quite used to the spectacular view.

She moved her line of sight a little, saw empty space and the silver-blue shimmer of a lagoon set into the world a kilometer distant, and looked down at the banks of video monitors racked up nearby, their flat screens all alight. Most of them showed the view from various camera locations, long-focus lenses trained on Lindsay, but two central screens displayed the view from Joel Dayde's camera. Judging by the wobble, Lemon guessed that he was shooting straight zoom; in the lab, they would be able to reprocess Dayde's recordings to take the brutal swing out.

It was enough for now that Dayde was out there. If they were to do anything about the threat Lindsay represented, they needed time, and that meant they had to give in to the first of his demands—full audiovisual coverage.

The frame lurched in a stoned flamenco, panning insanely from ground to ground, and Lemon looked quickly away from the screens, a little seasick. She was thankful nobody had thought to activate the immense screen that formed the far wall of the boardroom.

Petersen dropped a trimmed and stapled printout onto the table in front of her, and stood looking down at her. Lemon gave him a cold look, then started flipping through the print.

"Back to work, Petersen," she said. "See if that scan I asked for is ready yet."

"Yes, ma'am."

Push button, get reaction, she thought, not bothering to look up and watch Petersen walk away. It was a hell of a situation, and everybody was having trouble believing what had happened; but, deep down, it had gotten them all, a hollow certainty that it was going to happen. . . . She wished she could comfort Petersen, but she didn't dare try. She was badly understaffed now, and couldn't afford to lose him to hysteria or trauma.

She tried to avoid visualizing the explosion of her body in vacuum, and failed. She could barely even submerge it. *Just another kind of pirate*, she thought, *with another kind of idea.*

So where the ransom is, miz wire-waist?

She went through the biography, finding nothing startling. She hadn't

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expected to—Lindsay would have to be clean to make it up onto Alco Five. He had useful skills, and he had no family—wife and children deceased, according to the biography. No history of radicalism, not even as a student, and seeing the location of the university he had attended, she had to smile. University of West Indies, the home of Third World radicalism. Her old man had been to UWI.

She looked up at the screens. Petersen had sat down behind the video control console, and had patched Dayde's lurching signal into a processing unit, stabilizing it. Dayde seemed to be closing far too fast on Lindsay—the fault of the zoom, she decided. She studied the man wearing the wing assembly, automatically checking features against the white-light holograms Petersen had brought in with the files: good-looking, in his middle forties, a well-groomed man who could as easily have been African as Jamaican. His clothes were medium-expensive, well-made, fashionable by Earther standards. Lemon, by comparison, was hardly dressed, in typical orbiter fashion—a few square inches of fabric in the correct color, and a badge, and that was her uniform. Santos dressed in a similar manner, though Jeff Petersen had retained a preference for a full coverall.

Lindsay, still more than half-Earther, handled his wings with free grace, his days as a hatchee flier long gone. He had been aboard only a year less than Lemon, and had hardly been the most prominent citizen of Alco Five. Lemon couldn't remember ever having met him or hearing his name mentioned.

Lindsay was watching Dayde approach, smiling. Lemon saw two objects in the Jamaican's hands. One was flat and square, while the other, a squeeze trigger, was the shape of a dill pickle with delusions of grandeur. If Lindsay was forced to release the trigger, it would activate everything it was radio-linked to. Nice, neat, and frightening. Lindsay wasn't stupid.

In fact, Lemon thought, as Lindsay turned the other object over to show it to Dayde's camera, he was a sneaky shade of brilliant. The thing was a standard portatel unit, and was full coverage. It could pull in TV transmissions from the orbiter network, and Lindsay was carefully ranging through the available channels, demonstrating exactly what he wanted.

Lemon felt sick. She had to make three attempts to slap the deskcom on. "Get me com control."

There was a short pause, then: "Com control. Glicksohn."

Lemon kept her eyes on the screen. "Larson, patch into my security channels. I'm picking up remote TV from Dayde, and you're going to have to get it out on all the channels you can grab hold of. I want a closed broadcast, just Alco Five—nothing's to be transmitted out, okay? Can you get hold of the channel readers from other orbiter channels? This guy lives here, so he'll know the faces and the logos—can you make it look real for him?"

The silence that followed stretched her nerve until she was almost at the point of screaming. If Glicksohn failed

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to help her now, the problem would be straight out of their hands. There was enough potential for mass panic on Alco Five now, and, if it could be contained here, she didn't want panic spreading to other orbiters.

She didn't think it could be halted. There would, at the least, be witch-hunts.

"I can do it," Glicksohn said, startling her. "It'll take time."

She was only slightly relieved, and the announcement didn't help dissipate any of the tension. "Do it as fast as you can, Lars; I need that trick yesterday. The day before. Last week. Fast even."

Lindsay was still flipping one by one through the channels, turning the portatel momentarily to look at the screen before turning it back towards Dayde. There was no change in Lindsay's calm expression, and Lemon wondered whether or not he was drugged. Ganja—marijuana—she discounted; smoking wasn't allowed on orbiters, and smuggling was impossible. There hadn't been anything in Lindsay's file to indicate that he had been a Rastafarian, though she suspected he might have flirted with the cult while at UWI. A lot of West Indian men had played at being Rastamen in their younger days, though very few women had tried it—the cult discriminated against women in the most primitive manner possible.

She made a note to check various drug possibilities, including THC, the active chemical portion of marijuana, as an afterthought.

She hit her deskcom. "Dayde, hear me?"

"I hear you," Dayde said. His voice was pitched high, shaky, and he had regained his original accent. The height-fright of a hatchee flier, she thought, plus the fear of explosive decompression. "You see him?"

"I see him," she said, trying to keep her voice even and calm. "Can you get a flymike out on him yet?"

There was a low mutter from Dayde. "No way, no way. He'd only see it on the way down." Another mutter. "Christ, I'm not doing so goddamn good myself."

Lemon sighed, gritted her teeth. "Try, Dayde, don't crash out. I get a feeling I need you a helluva lot more now then I thought I did."

"That makes me feel *soooo* wonderful, lady."

Lemon cut the link, opening another channel. "Larson, damnit—"

There was a sudden low vibration under her feet, and she heard the quiet thunderclap that went with it, well in the distance.

Petersen's soft scream was drowned by the multiple-tone howls of emergency alarms. The open doors at the bottom of the boardroom slammed shut, the signal strip above them flashing a brilliant, bloody red.

Lemon grabbed the edge of her table, staring at the flashing strip, almost oblivious to the cramp in her thigh.

Keri Santos was by her side a few seconds later, pushing a plastic cup into her hand and pressing a medical wafer against her bare shoulder. The drug in the wafer was fast-acting, and relaxed her within a minute. There was just

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limpid water remaining in the cup.

Eventually, she said, "Jesus."

"He's warning us, dear," Santos said. Lemon saw the patch on Santos' pale shoulder where another wafer had been.

Lemon's hand shook as she carefully put the cup onto the table. "He means it."

"I didn't doubt it. He'd have to be truly bozo if he didn't mean it, all the way."

The whooping and screaming of the alarms died away, bit by bit. Lemon turned her head, saw Petersen slumped over his console. She didn't say anything about it. She wasn't sure it would be fair to him to say anything about it.

Slowly, she said, "How many . . . how many dead this time, Keri?"

Santos shook her head. "Give me time to check."

Lemon nodded, then settled back, slumping a little. The drug the wafer had pumped into her system was helping her just a little—enough for her to function with some semblance of normalcy. The fear didn't seem so bad now as it had been. Now it was more like she was standing on a ledge fifty stories up—and she had conquered her height-fright long before, as a hatchee flier going off the eyrie platform for the first time.

She finally straightened up, seeing the call light on the deskcom. Glicksohn, waiting for her. She said, "Lars?"

There was a low mutter, half an oath. "Give me minutes, sweetchild, let me work." His voice was full of panic, and Lemon had a delirious vision of him running around in frantic circles. Not that he had that much to worry about—com control, like the boardroom, was in a well-shielded part of the orbiter. "Got one on channel forty-six, we're coding eleven and twenty-three now."

"Scrambling all outside input and faking our own ents channels?" she said. Getting back to business helped ease her mind away from fear of the situation. She looked up and saw Santos working at a computer console. The woman mouthed *panic*, but signalled that it was coming under control.

"Yah," Glicksohn said. "I ordered direct patch to our rebroadcast transmitters and got the studio to program tape programs. We'll skip a couple things, but I don't think anybody'll miss 'em. Also, I've got a combined entertainments flying fack on line—channels from Polygram, CBS Blackrock-In-The-Sky, and Twenty-First Fox all in together. I'm delaying the Polygram channel on tape; we'll punch in in five minutes. I'm having to steal com time from everybody for this. . . ."

"Keep blasting at it, you'll knock it down. You've got my authorization if anybody squeals—full priority. Watch?"

"Am seeing like on a smogless day—got some bad frights down here. Slowing me a bit."

"Here too. Jeff Petersen passed out. *Don't* spread that."

Lindsay was watching his portatel with an expression of mild triumph. He looked over the top of the unit, eyes coy-sharp, watching Dayde approach-

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ing him, flipping to another channel. His expression faded, and Lemon, watching him, was scared. A terrorist. Almost impossible to believe.

"I'm dredging, Lemon," Glicksohn said. "Damnit, this is moving too goddamn slow."

"Keep it rolling, Lars. Who's come in?"

"British Steel just punched in, Congress Library Orbiter . . . but they want a back-broadcast to put on file—"

He sounded doubtful, and Lemon sympathized with him. Congress El had people who could bitch and filibuster for weeks non-stop, and she had neither the time or the strength to put up with it.

She said, "Give it to them, but put it out scramble and full digital code. Are we line of sight?"

"No. No laser."

"Damn. Okay, however you want it, but just make sure nobody can tap in on it, okay? Kill it if they try to bounce it back out again—call it copyright, maybe they'll get the message."

"Seeing like daylight," Glicksohn said, and then there was an empty pause that left her wishing she could do something with her hands. "Punched in on fourteen, going in on seventy-one."

"Keep me updated, Lars," she said, and switched back to Dayde's channel, fidgeting and wishing there was more she could do. "You in close enough yet?"

"No I'm not," Dayde said, growling, getting angry now. "For Christ's sake, lady, don't keep birding me, I've got trouble enough *now*, just bein' where I am, so just lemme alone awhile, okay?"

Names and numbers were coming through faster now from Glicksohn. Two U.S. Steel factories—by now, Brasco would be on the verge of starting his own witch-hunt—NASA Space Eight, Space Eleven, and Space Sixteen, the other four Alco orbiters, Sony-Mitsubishi, the Italian orbiter, WEA Entertainments.

Lindsay, depicted on her monitors, was starting to look pleased, as he found more channels with his picture on. Lemon wondered how long it would be before he realized that he was being had—perhaps it didn't matter. They were in a big enough panic now, and just wasn't possible to keep the thing boxed in. The only thing missing outside Alco Five was details.

Keri Santos slipped a sheaf of plastic printouts onto the table in front of Lemon. "A partial version of that scan you wanted. From the way it looks now, I'd guess he's been rigging anything up to half the tricky compartments near the hull—maintenance, storage, access, all the tight places, all places it's hard to get without using doors. I'm not sure, but I get an itchy feeling he had a lot of help."

"And?" Lemon said.

Santos made a moue. "The help is no longer with us—crew turnover. I'll straighten out a list in a while, and get the Peelers on it, but I don't expect any joy. If Lindsay had help, all the help'll be gone."

"And the bangs are ready to knock holes in us anyway," Lemon said, flip-

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ping noisily through the sheets.

"No kidder there, dear—he aims to make us look like a colander. The first bang was a demonstration, the second I'm not sure—it could have been deliberate, and it could have been accidental. All those things are shaped charges, by the by, designed to produce fracture lines, real hell-job to fix. Enough of them and we'll break up, frag like a rock."

Lemon itched for a cigarette or a spliff, and knew she could have neither. She'd had to quit smoking tobacco and marijuana on getting the job with Alco; smoking was illegal on orbiters. On anything in space, for that matter. Right now, though, she could hardly care less about the law.

She sat back, tapping the stack of plastic sheets with her middle finger. "It's a hell of a way back down."

Santos shrugged slightly. "There's two more that won't be waiting to fall, *shiksa*, not now. Nobody you know personally."

"Oh, sure," Lemon said. "Nobody I know, that makes it alright, yeah?"

"No." Santos squeezed the diminutive woman's bare shoulder, gentle. "It's just a lot less painful. It could have been somebody you liked, maybe."

Lemon sighed, shook her head. "Yeah. Goddamn." She looked at the monitors, growing angry because she was impatient and scared: Dayde still hadn't gotten a mike out on Lindsay. She struck the deskcom with more force than was necessary, trying to hurt it, and only bruising her hand. She rubbed her hand as she said, "Dayde, back that zoom off all the way to straight focus. Now."

Dayde zoomed back, reducing Lindsay to a black, bewinged, distant shape in the center of the frame. There was a momentary lurch as the video computer adjusted the output, cancelling its compensation.

"Where are you wearing that camera, Dayde honey?" Lemon said.

A disgruntled, tremulous sigh. "Headband. I'm usin' tooth controls—I guess you *do* figure I need my hands free. Unless you want me to play at bein' Icarus, you know—"

"Copy, copy, copy. Look, I *need* that mike on Lindsay as soon as poss. I'm in a fly-by-panic situation down here, and I need all the help I can get."

"Lindsay? That his name?"

"Yeah. Goddamnit—"

"For Christ's sake," he said, almost shouting. "I'll get the goddamn mike out on the nigger sonofabitch as soon as I goddamn can, so lemme alone on it, get me? For Christ's sake, will you try and get it through your goddamn head I'm not expert at doin' this—Christ, I hardly rate as a friggin' *beginner*, lady."

Lemon sat in frozen silence for a few moments, shaken.

"My God, Dayde," she said, at last, her voice soft. "We're both beginners."

4

"So you're a newsie, eh?"

"Yeah."

Lemon watched the bank of screens before her, her eyes narrowed, her small, slender body tense. She needed

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Dayde to keep Lindsay occupied, needed him badly, and if he turned out to be less than the expert media man he was supposed to be. . . . Her eyes flicked sideways, and she looked, for the thousandth time, over the screens that displayed frames from ground-based cameras, long-focus lenses picking up pictures of Dayde and Lindsay, a few meters from each other at midpoint. Both fliers now had their balances equal, to prevent a fatal plunge. It was possible to fly from midpoint to ground without injury, but very few tried it. Errors in flight path could easily kill a glider.

Her attention was taken again by the trigger in Lindsay's hand. The Jamaican handled it with casual ease, and that scared her—he wasn't desperate, he had nothing to lose by letting go and killing them all.

"Well, maasta," Lindsay said, and Lemon winced at his sarcastic tone, "is you who's the nose for news, and must be you who knows how to do interviews."

There was a vague mumble from Dayde.

"Ask a question," Lindsay prompted, cheerfully. "Anything. Is not'ing me hidin'."

"What?" Dayde said, stupidly.

Lindsay laughed slightly. "Country talk. To translate—" and he followed with a hammy English accent—"I am not hiding anything. I have no secrets. Ask me something, Sir Nose for News. I'm not going to blow you up yet."

Lemon's hand snaked out, slapping the deskcom. "Humor him, Dayde!"

Another vague mumble. Dayde's nerves had him. Lindsay had set him off, deliberately she thought. "Wh-what do I a-ask?"

Sonofabitch. She growled, low in her throat, terrified. "I don't care if it's—"

"Is you, maasta, not me who's—"

"—inane, *say something*!"

"—so why don't you try something routine?" Lindsay finished.

"Ah . . . wh-what's your name, Mr. Lind—"

There was an awkward gulp from Dayde as he stopped speaking. Lemon wanted to scream, and didn't dare.

Lindsay chuckled, gently. "What *your* name is, Mr. Newsman?"

There was audible relief in Dayde's voice as he told him.

"Stall him," Lemon said, evenly, "and string him. Make him a happy man even if you have to immolate yourself to do it."

And maybe, she thought, she would find out why Lindsay kept switching back and forth from clear, supposedly educated speech to country talk. She could understand him well enough, but it was more than a little confusing and disorienting.

Perhaps it was meant to be.

"Well," Lindsay said, "Mr. Joel Dayde, I am Lovell Lindsay, and I am Chief Projects Engineer of Alco Five, and had I not done this, it is entirely possible that I would in the next few years have ended in a supervisory management position, with further prospect of advancement. However, as it stands: when you big, you no see how you jus' large?"

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"Huh?" Dayde said.

Lindsay smiled. It was an engagingly warm smile. "When you grow bigger, you don't necessarily become impressive—just big. You just take up more space, you just become a bigger burden. It's perfect for politicians and all those who like to boast. So, anyway, I've sacrificed all my future prospects for this. There's a holy motive, of course—all terrorists are heros, to themselves."

"What's your heroic motive?" Dayde said. "Money?"

Lindsay smiled. "Later, Mr. Dayde, later; there is a time for all things, hmm? I think it's time for an unpaid party political bulletin, on behalf of myself—be certain this is transmitted, noh, Mr. Babylon-Newsmaker-man, is a raas t'ing me mus' fe say: you're already aware that I have the power at hand to tear holes in this orbital factory. I am sorry if my demonstration killed anyone—"

"Three people," Dayde said.

"Statistics, if I destroy the factory," Lindsay said. "But that's not all, you see. Is a fancy we tek fe do a t'ing: at will, I can cause this overblown housing project to enter Earth's atmosphere. Like a meteor, an asteroid—did you ever see any of those filmshows, Mr. Dayde? Where a meteor or whatever comes—"

"I saw a couple," Dayde said.

Lemon sat frozen, watching Lindsay's calm face, and wanting to panic. Discussing movies, for God's sake, the man had to be crazy.

Maybe. Like a fox. "When you han' in a lion belly, tek time, draw it out," she said whispering, lowly.

Santos, nearby, said, "What?"

"Nothing," Lemon said, shaking her head. "It was something Mama used to say. Why she and my old man took off for the States. Oh, God. I feel like that now. I've got a crisis and I want to get the hell out."

"I'll race you for the shuttle," Santos said, and she was only half-joking.

Lindsay was saying: " . . . if triggered, Alco Five will enter atmosphere at such an angle as to minimize burn-up from friction. It will strike mainland, *populated* mainland, and the result will be an historical event on the order of Hiroshima. The resultant death toll will, of course, depend on strike area, and what measures are used to prevent the strike."

Lemon couldn't tell whether Dayde was shaken by that statement, and she didn't dare turn her head to see how Santos was taking it. She herself was shivering, though it wasn't cold.

"This trigger in my hand will activate the charges scattered about Alco Five, additionally triggering the main thrust unit; once taken out of orbit, this orbiter will begin its fall—once orbital decay has begun, it will continue at such a rate that there will be no stopping it."

Lindsay paused. Lemon held her breath.

"There are," Lindsay went on, "safety devices. Attempts to tamper with the devices I control will trigger those devices. The results will be the same."

Lemon kept her eyes on Lindsay's televised face, waiting for more.

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Lindsay waited, silent.

She groped out blindly, clumsily, punched at her deskcom. "Get suits outside, on the skin, run a full check and scan. Devices on attitude control and other balance gear, strange stuff, anything that does a variation on standard operating equipment. *Don't* touch a goddamn thing, just check it, get it on plastic, and get it back to me or Keri Santos. Cover everything. Inside, outside."

Dayde said, "Why?"

"Is plenty reason me have, rasta." Lindsay chuckled. "Bu'n Babylon. Give them time to make sure of my threat."

A light flashed on Lemon's deskcom, and there was a soft buzz. Glicksohn said, "Congress Library wants to talk to you, Lemon."

Lemon said, "Tell Congress El to go cop with SunSailer. That's the nearest asshole they've got."

Another light, another buzz. Lemon punched a hold into Glicksohn's channel.

"Earthside, ma'am, President Bell."

"I'm busy," Lemon growled. "Tell him he can sell his Alco stock whenever he's ready." She wanted to howl; too many things circling her, locking her in, an iron maiden of events.

"—says it's urgent, ma'am. I'm sorry, I can't shake him."

Lemon put a hold on the channel, opened Glicksohn's. "Lars, I need a ringpatch—bounce ye Prez to Congress El, let 'em hot-air each other to death. I don't need him back-riding me."

"Seeing clearly," Glicksohn said. "Bugged?"

"I'm so bugged I'm starting to feel crawly like anthills."

"Jeet it. We'll ride out, baby."

"Wheh." Lemon rubbed her forehead. "*Here's* hope."

"Love."

"*Mmmm*. Or work. Slave on, Lars."

She closed off the channel, and slumped for a moment, feeling smaller than ever. She was hardly aware of the channel light winking out on her deskcom, was only faintly aware of the renewed exchange between Dayde and Lindsay. She finger-stroked her temples, tired already, though she had hardly begun. Work to be done—and her world to save.

5

"—Orbital manufacturing facilities changed so many things after they were legislated into fashion, you know. Multinational corporations had seen their futures in them already, so it was hardly a drastic move, not even an unexpected move—you know how the corporations are. They have their lobbies, and their ways around laws that might hurt them. The cost was high, of course, a massive expense in terms of capital, but the profit potential over the years is so incredible, they hardly had any choice. And the basic costs, anyway—"

"Are passed onto the consumer," Dayde said.

"Exactly," Lindsay said. "Pharmaceutical companies are a good example, too—did you know that they have been known to make back the costs on certain drugs by marketing them heavily in the Third World? They couldn't sell them in America or Eu-

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rope, but they had no real restrictions in the Third World. I had friends, you know, who were ill for months because they couldn't get the drugs they needed. I remember one who died. . . . You see, he needed a certain type of antibiotic, because he was allergic to those drugs we had available. It happened all the time. Magnificent vitamin pills, tasty baby formulas, all the raas shit. Nothing we *needed*."

Dayde said, "That's not new. They've been doing that since biblical times."

"And they are still doing it, so it still has to be talked about, nuh. And seeing that I have something to talk about, then someone must listen. No one listened the polite way, so we steal air time, make an impact, and get our message across that way—all very simple."

"As you say. You don't have to pay for my time."

"Oh, fe true maasta. Is de wicked man 'im pay tribute fe see niggerman a talk. It's accountancy that's the death of us all—mining, you know. That's one area they went over. Mining was changed so much by legislation and the space factories. New areas were opened, other areas broadened. According to the accounts, you see, these corporations would be wasting too much money, too much capital—all potential profit—on fuel and OTRAG-type payload launch systems; cargo-shuttles were even worse. So they settled on one financial fling, and now they mine the moon and the asteroids. Mass drivers are cheap, of course—"

"Moon-mining's more convenient," Dayde interrupted. "The gravity well isn't so deep, and you don't need so many people."

"Oh, of course. And your resources are effectively endless, you don't damage the ecology, you don't de-beautify anything, and you feed your mass-drivers on solar power and unrefined ores. The retrieval systems involved at the processing end are simple, too. Cheap and simple. That's how they like it, and that's how they have it, eh?"

Watching the screens, Lemon said, "He's anti-corporationist." She was scratching for motives, and she knew it. So did Keri Santos, who was dividing her time between the screens, and her work. "Or maybe he's profiteering."

Santos shook her head, waved a write-stick at the screens; the lighting formed shadows in the hollows of her cheeks, giving her a vampiric look. "No way he's out for profit, Lem. He'd have dropped his money demands by now. Also, there's easier and saner ways to squeeze a bundle out of the system."

"Straight political, you think?"

"Probably. The Italians used to do it—take over TV relays. They used to haul up a small transmitter and beam straight into the microwave dishes, make their statements, and get the hell out."

"Why?"

"Advertising—it's the best way to get the message across. This is impact advertising; *somebody* has to take notice." Santos hesitated a moment, watching her computer displays. "The thing is, decompression only hurts *us*,

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so whoever's behind it all has had to go a step further. Dumping us makes others get worried—they start watching the skies, waiting for us to come hurtling down. Penalty of the space age, dear; things have been falling out of space from the start."

Lemon nodded. The sick feeling had managed to reduce itself to a nervous stomach, and if she managed to come out of it alive, she'd be glad to have her first ulcer. "Goddamned mess. I'm surprised nothing's hit us. That outside scan ready yet?"

The blonde woman consulted her computer terminal. "No. Proving a little difficult. Give them a while; we're big."

"—economic disaster for numerous Third World countries. Consider economic mismanagement compounded by deep-seated political corruption and petty thievery, especially in countries controlled more or less by multi-national corporations. Consider a country ravaged by runaway inflation, strike after strike, and blatant inefficiency and *laziness* in major industries and essential services—which suffer for want of spare parts, replacement equipment, and some sort of standardization. Throw in riots and runaway crime instigated for political purposes, and add multiple shortages, constant devaluation of local currencies, and even occasional *natural* disasters." Lindsay paused for breath, then plunged back into his speech. "Consider one of those countries, barely able to beg loans from world powers caught in the web of multi-national corporations, only able to beg aid because of *one* natural resource—be it copper or tin or bauxite. That same country is unable to find an economic balance in other directions because of powerful monopolies on such as the sugar market. Unable to find a true political balance because experiment is met with undermining tactics—does anybody here recall what happened to Chile?

"Consider that same country: one resource, on the thin edge of survival. And its single resource is suddenly found to be cheaper and easier to mine and exploit elsewhere. What happens then?"

"Collapse?" said Dayde.

"Collapse," Lindsay echoed. "*Supernova*! The corporations abandon the restraint of landbound operations, and their hooks leave the countries they were into. The Third World, bottle-fed by its parasites, is suddenly abandoned, without warning, without the possibility of finding alternate sources of income, of stability. The economy splinters and industry fails completely, without outside support. Government, never stable in any case, falls completely, and petty politicos flee to the safety of their secret bank accounts and overseas residences. Jobs end throughout the country, hungry people go hungrier, begin to starve, and many grow sick for lack of imported medicines; diseases barely controlled *explode*—dengue and malaria, cholera, dysentery . . . is runbelly we call it.

"Collapse, Dayde. Depression, pure, modern, unrelieved depression. So. One or two states collapse, is old Mooma Bear Russia you see sweeping

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sufferer nation to she warm bosom fe protect them from the wickedness of the vile capalistic oppressor. Who cares what color of politics paints their lives as long as they are fed and clothed and looked after?

"What happens when twenty, thirty, forty states collapse? Well, maasta, is then *they* must fend fe *themself*!"

"But self-management of exporting industry—" Dayde started.

"*A t'ief dem*!" Lindsay's vehemence caused Dayde's transmission to flicker as he flinched. "*Raasclaat* incompetent Rastamen socialist thieves—name me an example of stupidity, *this* would be where you find it, star. Same people deh in government who don't want to improve the economy but *restructure* it."

"Importing of technicians," Dayde said, "and—"

Lindsay snorted. "Is you will work for *Monopoly* money?"

Dayde was silent.

Lemon felt nauseous again, watching and listening. Lindsay's argument was stuffed with emotional angles, and hung heavily on his ability to narrate, but he had facts behind his argument, solid facts that could be verified by anybody who knew how to use a library, facts that would make any attack on his argument not only difficult, but damn near impossible to carry through effectively. Even Santos was silent now, taking it in.

Lemon felt threatened. Lindsay's presence on board Alco Five was forcing her to speculate which side of the argument she might now be on had her parents made different decisions years before. Her parents had seen the collapse coming towards the end of the seventies, and had suffered the terrific expense of abandoning their island home for the unfriendly streets of America, where Lemon had been born. From then on, it had been a fight, and Lemon's eventual response had been to head directly for space, and the Fourth World.

And back to the start. Her father had come out of the alumina industry, and she had headed right on into the space-side aluminum industry.

Now here was her parents' past, threatening her new world. The unpleasant little details they had managed to skip, the sort of nasty, painful image that, tucked neatly between commercial sweetnesses and candyfloss sob operas, could be ignored or superficially glossed over. People had found new paradises, provided by active corporations, to be used once the old paradises shut down.

Who in hell, she thought, *gives a damn about damn foreigners*? Even the students had found more interesting causes.

It was her problem now, had made itself her problem.

"There were more riots," Lindsay was saying. "Burnings. Terror is a mob, nightmare is a township of empty bellies, empty eyes, and sickness." Lindsay's voice was gentle, soft, but Lemon could feel the pain, could see the lines in his face now in a different light. Oh, she thought, he was good; he had been there, and he had been trained to display that fact to his audience.

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Make them feel the pain. "You see, your world-saving ecological technological dream scheme destroyed all my hopes and dreams, destroyed my home, destroyed my countrymen, killed my wife and children. Is a duppy, me, is how I tell you. A ghost."

" 'For every step forward, there has to be some pain,' " Dayde quoted. It was a school kid polemic, transmitted computer to computer Earthside. There was a strange hollowness in the reporter's voice, as though he had taken only a shallow breath and was trying to make as much use of it as he could before drawing another breath.

"Oh yes," Lindsay said. "Is truth dem a tell, fe some. But I would sooner see my world dying around me than to have to bear my children dead in my arms again."

6

The crystal matrix that comprised the far wall of the board room was alive with light. Computer-generated graphic displays grew, rotated, stopped, changed, rotated again, stopped, altered subtly, rotated once more, stopped. The resulting frieze was partly Earth-map, partly trajectory plot. Lemon studied the glowing maze carefully, unsurprised by the gigantic display's resemblance to a war room display. She would have liked to have seen NORAD's current war map.

Sitting behind the control terminal at the other side of the long conference table, Keri Santos said, "This is only assumption, but if he's rigged up an operational retro unit that can dump us—and it's highly possible he's done just that—if he's got a retro unit on us, he'll want to maximize destruct potential. That means he'll be trying to avoid shallow entry angle, which'll just bounce us off and out, and really steep entry, which'll fireball us, break us up and burn us out in small chunks . . . that last one would mean too little in the way of debris strikes, and probably too few serious effects beyond destructing us."

No serious effects beyond destructing us. Lemon didn't dare take her eyes from the changing graphics on the big screen; they seemed to echo the computer tone that speckled Santos' words. *I wanna go home. Me wan' step it in a Babylon street.*

She said, "So?"

"Well, in five minutes we'll be in perfect position to be dumped dead center on Baltimore."

"Lousy end for a flying fack," Lemon muttered. "Dead next to Philly. I guess it *could* be worse."

"Right. *And*—" The graphics changed again, the computer writing a map of the United States from Virginia to Lower New York State. A glowing trajectory line cut across four states; a point on the line gave strikepoint, now a little below Baltimore. "Taking them in turn, he can dump us on Baltimore, Philadelphia, Jersey City-Newark, or New York." Santos fed further instructions to her terminal, and the graphics altered again, displaying plots for further orbits. "I suspect we might have been picked for orbit potential. Over the next few days, we make passes over a hell of a lot of major cities and living areas." She wrote in another instruc-

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tion, and points lit in the city. "Even got some seaside targets—couple undersea places on that bunch of lines. Slam a flying fack down *anywhere* touchy, you'll get a hole the size of Atlantic City."

Petersen sidled up to Lemon's chair, slid a sheaf of plastic sheets in front of her. His hands shook, but he was managing to keep himself under control now. He was even operating with a little more than his usual efficiency.

He said, "That data you were calling for, the outside scan. *Something* out there that could conform to the general dimensions of a retro unit with fuel, but no way to be dead sure—it's screened and shielded, and we can't get through with anything."

Lemon looked through the sheaf of reusable sheets. "Tricks and triggers?"

"We think so. There's booby and trick emplacements, or what looks to be them. We can't maneuver easily for a close look."

"Okay." Lemon finished scanning the sheets, found nothing she could hang a plan on, and pushed them away. "We're going to have to *try* and do something about it, so I'll need a scan over and a scan under. The way Lindsay's acting now, he's looking for martyrdom and sainthood." Lemon was aware, almost with an unreal-feeling objectivity, that she was speaking less to Jeff Petersen than to Keri Santos. Things always worked out that way. Once she found an ear that seemed the least bit sympathetic, she used it, and it too often seemed that the most sympathy came from women. She had quit frightening herself with the implications of that in her early twenties. *Que será, será.*

Petersen said, "We can try zapping it."

"*For*get it," she said. "You don't have a clue where you're shooting, and if that thing is mirror-shielded, it's your ass in the flusher."

Petersen stiffened slightly, then nodded and left. Lemon watched him go. The man wasn't much use under normal circumstances, and right now, he was melting jelly, permanently scared. Yet getting the job done. She suspected he suffered from insecurity; maybe he would improve.

She needed a good staff, a really big staff, not a small collection of good people and a lot of fill-in helpers from other areas. But who the hell ever needed security staff in space? All she had ever had to do until now was lightly police the factory to deal with the inevitable minor conflicts, violent outbreaks, and kleptomania. Typical company town law. *Now—*

She tried to bury her desperation under business, before it overwhelmed her. Panic was only skin-deep. "Keri, how's that compartment scan coming?"

Santos swiftly questioned her terminal, and Lemon was thankful for both her brute efficiency and her quiet understanding. "Almost done. Very busy little squirrel, our man."

"How's the percentage look now?"

"Thirty percent on compartments. From the breakdown so far, the scattering seems to be random . . . I'm not sure, could be." The woman's long fin-

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gers played over her keypad with precise grace. "It'll be a while before we know for sure whether the stress pattern is designed to wreck or dump an amount of mass."

"Okay." Lemon glanced at the big screen, at the slowly changing computer plot, then at a computer display. "Can you damp potential blasts?"

"No go, dear. We can't touch the bangs themselves—so if he lets go of that dead man's whang, we get opened up to vacuum. If those things pop in sequence, or together, I don't think there's anything life-support can do about it. The decompression'll come too fast and do too much additional damage, plus there's fracture lines produced by those things."

"And they're tricked?"

"Scan says every one they've hit on so far. All doors. I'd like to try robots, but they aren't flexible enough."

Lemon sat back, sighing, casting about for ways and means in the convolutions of her mind. "Is there *any* way in?" She turned her head to watch Santos working in silence, forehead furrowed with concentration, at her terminal.

Finally, she looked up.

Lemon said, "So, what?"

"We might have one way in," Santos said. "But it's tight."

"Shed fur. Tell."

"Ventilation. Airshafts. Came with that thought on using robots."

Lemon settled back again, aware of the display beyond, not watching it, watching Santos instead. "Can you scan through and clear 'em? I want detail." Lemon was silent for a moment, cobalt-dark eyes flickering with light from the screen. "There's gotta be some way to break that sonofabitch's back before he gets tired."

7

"Do you blame the multi-national corporations for what happened to you?" Dayde said.

"Should I?" said Lindsay. His amiable expression hardly even flickered. He had managed to maintain his devil-may-care attitude for far too long for anyone to assume it was false.

"Why hijack an orbital factory?"

"They are newsworthy, Mr. Dayde. I am able to make my stand with some assurance that I *will* be heard, that someone will *listen* to me. It's hardly good publicity, is it? Perhaps someone will be moved to survey the causes behind this . . . hijacking. Perhaps it will force someone with influence to listen to the pleas of dying nations, to help suffering people, to distribute some of that incredible wealth we are told about."

"Or maybe you'll be ignored as just another terrorist with a different way of making a name . . . and a nice way of speaking."

"Perhaps. But I can't stay up here forever. And when I get so tired that *nothing* can help—"

"You really intend to try pushing this place out of orbit?"

"Perhaps I might. I'm not concerned, Dayde, with murder for the sake of seeing blood a run. Feel a blood vibration? I'm more concerned with humanity . . . the rights of man, *all* the rights of man. Whether or not your un-

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seen policymakers and futurists care to let the thought be known, these orbital factories, and their offspring, they have made progress to a world-state inevitable.''

''But,'' Dayde said, plainly puzzled, ''there's resources for all . . . Third World countries were offered a share in commercial space, surely—?''

''By whom? Governments whose loans sank out of sight when granted? Russia? If you check, you'll find Cuba cost Russia two million dollars a day in the nineteen-seventies. Russia suffered. And what about commercial interests, the banks, the corporations with their multitude of boardroom interlocks? These same commercial interests whose sole concern is with endless profit and marketing, would they offer a piece of their power to little states who haven't even been allowed to settle on a fair political structure?''

Dayde hung quiet.

''You know, Joel, it's never a pleasant thing to see one's entire culture erupt into savagery. Cities dying, people dying, everything vanishing in flame and noise, the sound of gunfire day and night—''

''Viet Nam,'' Dayde said. ''Angola. Zimbabwe. Nicaragua. Israel. Iran. Ireland. Cyprus. England. Italy. New York. Los Angeles. Italy. South Africa. South America.''

''Ah, but this is more personal, you see, because it affects *me*, it is *me* you see bleeding, it is all people like me hurting because of a cause allied to money, not politics as such. Nah ideology kill we, is backra money, nah see it? Money burned my home, money killed my wife and pickney. We hurt. Some would prefer blind blank revenge . . . maugre dog tu'n fe bite you. Revenge like that is simple. Pure. But *I'm* a little more humane. A little more thoughtful.''

''Your demands are kind of nebulous,'' Dayde said.

''But I'm only the figurehead,'' Lindsay said. ''I'm the face on the screen, the star of the show. Is a Rastaman you want fe scare you pickney, heh?'' A bitter chuckle. ''I can be thrown away, Dayde. I'm expendable. I'm the leading player. I'm supposed to catch the sympathy and stroke the guilt of hundreds of millions.''

''For what? So you all can get handouts for the rest of eternity?''

Oh God, Lemon thought, *he's going to trigger him*. Her stomach hurt, her gut roiled, and she was starting to get a headache that she prayed wouldn't turn into a migraine.

She hit the deskcom. ''Christ's sake, Dayde, you goddamn fish bastard *watch it*!''

She hated herself for the quiver in her voice.

''We need help, Mr. Dayde,'' Lindsay said. ''That has a very serious habit—for fear of getting into this boring pseudo-technical garbage favored by the usual, *hem*, freedom-fighter—it has a serious habit of referring to something of financial value. Money, if you like. Help has to be paid for.''

''And if we refuse to listen?''

Lindsay made a hand-opening motion that made Lemon flinch. The image on

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the multiple displays jerked, Dayde flinching too.

"What," Dayde said, "if there's nothing we can do? Fast, at least?"

"I ask you to try."

"Money?"

"Assistance of all kinds. Movement towards statehood. America or Eurocom might absorb and make use of certain countries now suffering from deprivation. Africa will, given impetus and help, eventually be able to provide for her own. America absorbed Puerto Rico, Northern Mexico and lower Canada, the Bahamas. This world *must* become quinpartite. Five healthy political units would be more healthy than a handful of fat pigs and dozens of unattached, angry, *hungry* little states with bloody minds."

"Economically—"

"It would make little difference to the political units involved. It would have to be complete absorption—not control. Control cost Russia, cost the States. There would be some dislocation, some adaptation, but it would be no harder than absorbing, oh, Hawaii, or Puerto Rico, or Alaska, for the States, or melding a multitude of disparate states for Eurocom."

"It can't be done in a day!"

"Of course not."

"Then—"

"I'm *proposing* a solution. That's why I'm here talking to you. Would it require so much to implement the idea? For someone important to take up the issue? I'm only the first of those who might be ready to attack an orbital facility like this one, and, Mr. Dayde, I, bleeding or not, am by far the most reasonable. Nah mad dog, me."

"You're talking about a program of hijacks like the ones pulled off on commercial airlines by groups like the Palestine Liberation Organization and similar organizations?"

"Of that sort. But with different goals and methods. And the *eventual* intention might include attacks closer in spirit to those of the IRA and the Basque separatists."

"And with much higher potential for mass murder," Dayde said, "and wholsesale destruction of property."

"Yes, of course," Lindsay said, "but all radical political objectives involve an untoward level of potential destruction. Some commercial objectives have that *end* result, with resulting suffering for all. If ever you have the chance, investigate Chile. It's the best example. Did you know that a member of one of the most powerful American families once threatened an OPEC country with *war* should it deign to terminate oil supplies to the oil-hungry Yankee companies?"

Lemon hit a slider, cutting the sound level, and sat back, shaking her head, trying to work her way out of it. She worked for one of those companies. Yet she wanted, just a little, to side with Lindsay.

She picked up a wafer from the medikit Santos had left open near her, and triggered it to analgesic function. She patted it onto her shoulder, smoothed it down, then closed her eyes for a moment, rubbing her temples. Her headache was definitely threatening migraine,

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and she suspected she might have to find fifteen minutes to spare to have it electronically wiped out.

She opened her eyes again, to watch Lindsay mouthing away for a moment.

Finally, she said, "He's crazy."

She didn't believe it.

8

"It's been scanned from as many angles as we could manage," Santos said.

She twitched her director stick, and the graphic display on the big boardroom screen rotated about its axes. Lemon glanced from the computer image to her colleague, worried by her haggard, worn look. She looked fifteen years older than she was.

"We," Santos went on, "can't look through, can't touch it. If we go for the magnetic locks making it hug us and try repelling, it'll probably blow. We can't *see* it to stop it, which is the main problem. If we could see the unit itself, we could probably manage a good laser shot to kill it."

Lemon waved a suffering slice of full-house pizza at the screen, and said around a mouthful that tasted of semi-charred, rubbery Parmesan, "What if you fire it and then blow it loose as it goes?" She chucked, rather than dropped, the pizza slice onto the tray. Her mother had never really understood her liking pizza, but after rice and peas, fish tea, curry goat, and callaloo soup, junk food had become a bad habit.

Santos said, "The bang-points aside, there's a lot going to happen that we can't handle. By the time we knock it off, it'll have applied enough power to shake us out of our orbit. I don't think there's much chance of getting a big enough powerhead up here to delta-vee us back into place before we turn shooting star."

It was turning into a game of twenty questions. "And?"

"And if we blow it off haphazardish, it'll probably blow as it goes, within distance to rip us up and deorbit us. Same thing. Down we go, slow but damn sure. Near-Earth orbits are too touchy."

"Can't trash it . . ."

Lemon sat back, picking up her coffee cup, sipping the bitter dregs and not noticing the poor taste, staring at the big screen with an attitude that made it seem as though she expected the screen to suddenly chime and provide a neat, clean, cheap miracle answer.

Petersen was settled behind a dual console—the video operations console and a computer terminal linked to Alco Five's security computer—picking at a dinner that was even more arbitrary than Lemon's. He was a lot less shaky than he had been, far more confident. Lemon was sure he was doped to the eyeballs, but she could hardly blame him for that—much longer, and she would be leaning on stimulants. Her headache had had to be electrically treated; it had begun to interfere with her concentration.

Petersen's attention was taken by the computer terminal. He squinted at it for a moment, then looked up. "Report from outside scan."

Lemon looked around. "Something else?" she said, voice incredulous.

"Somebody down on the dirt getting

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pretty unhappy, I guess," Petersen said.

"I've got it," Santos said. "I'll bounce it up."

The computer generated graphic on the big screen was suddenly blanked, to be as suddenly replaced by brilliant stellar background; it looked cold to Lemon. A brightly hazy area in the upper right corner showed Earth's position. The view panned up and across, the video computer automatically adjusting brightness levels as Santos instructed the computer to steer a telescope unit in the requisite direction.

The view finally stabilized over the Atlantic. Santos punched in more commands; a series of magnification jumps made Lemon feel a little nauseous. The image changed slightly as Santos called for enhancement of her target image.

"There!" Petersen said, as a blank ring appeared on the screen. Centered within it was a sparkling silver shape.

"Hunter-killer," Santos said.

"Shit," Lemon muttered. She was numb.

Santos looked from her terminal to the big boardroom screen, then back to her terminal. "Chinese, designation T-six-six-nine. It's the chop-sockie edition." There was a brief flare of orange-white light from the miniscule shape of the satellite, and Lemon flinched. The satellite wasn't coming straight for them, though. Not yet. "Best type for splitting us into manageable pieces."

Lemon stared into the blue and white brightness of the screen until her eyes started to water. It had to happen, of course, once the news got around and people started playing with pocket calculators and home computers and finding out exactly what sort of damage several hundred tons of very solid alumina processor could do to a city or a township. The first big scare had been Skylab, and the fear had turned to laughter. The parts of Alco Five that would hit ground would be up to five times the entire weight of Skylab, and there wouldn't be any laughing.

She had tried to lock it in. Lindsay's backers had let it all out, at least on Earth, and from Earth it would filter up.

It could have been her father hanging up there in axis with the trigger for mass destruction in his hand. It could have been her father, mourning a wife and children. But her father had run out on the disaster, had abandoned the game in the early stages. Had become a migrant, officially hated by the nice Democratic Socialist government.

She was angry at Lindsay for making her feel guilty.

Softly, Petersen said, "That's not the only one . . . there's more."

"He's right," Santos said. The view altered, picked up another satellite. "T-eleven-two, USA. President Bell's answer to your answer, *shicksa*. That's what you get for expediency over diplomacy."

"Somebody else," Lemon growled, "can kiss the bastard's ass. I didn't elect him."

Santos snorted. "Careful, girl. This is the old world's answer to balky colonies. Look—T-oh-four-seven, Britain, T-eight-four-four, Indian Federation. This isn't independent action, Lemon,

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this is international agreement. Better expect a lot more on the way."

"Maybe Lindsay's right," Lemon said, softly. "They're coming out arm-in-arm. He's making them listen to him."

Santos shrugged, wearily.

Petersen said, "I'm getting whispers from Alco One and Three. One says they're tracking a Flying Ivan and a Cossack jumping their orbits. Three says they're being haunted by an Anzac."

"Petersen—" Lemon started.

She went silent, her mind careening through fields of possibilities, barely stopping to consider each one as she came to it. *Something* had to be done, and fast, but she couldn't rely on last-second inspiration to save her. She wasn't even sure there *was* anything that could help her—hammering and hammering against the problem hadn't brought up any solution.

"Damn," she muttered. "Keri, give me a broad look at the area around that thrust housing setup."

The screen cleared again, the outside view replaced by a mix of computer generated graphic and straight visual image. Lemon studied it, intent.

"More area."

The graphic altered.

Lemon was silent for a minute, concentrating on the display. Then she said, "Can we afford to lose a real *big* chunk of skin?"

Santos nodded. "Sure. There's a couple of dozen design areas allowing for nasty contingencies. Thinking more of a violent meteor strike—this position we're in has us sitting right in the middle of a gravity funnel that just loves meteors. That was one reason plans for colonies had 'em all out in deep space. Less traffic."

"Hmm." Lemon stuffed fingers through her springy hair and gave the top of her head a rapid, painful scratch. "Okay, let's be more specific. Can you cut a section out?—*That* section. Without setting that thing off too close to us."

Santos went to work, fingers flying over her terminal keypad, lips pursed as she worked.

"You'll blow us to pieces," Petersen said, dully.

"Did I ask you?" Lemon said. "Shut up." Lemon wondered if Petersen could consider violent action in dangerous circumstances. If he could, she might have to knock him out. "Sit tight. I'm not going to risk anything I can't be sure of."

She thought about being back on Earth. Sure. And be stuck in a crappy, dead-end, nine-to-five job, kicking somebody's ass and getting put-downs galore from cocky six-foot three superstuds without brains to look beyond the next pussy that meowed for money. The knowledge that she wasn't going to be tall, willowy, and made-up *moderne* fashionable/beautiful had come through slowly, locking into place with a lot of pain. Eight days out of ten she couldn't get laid without feeling it was charity. Still pickney to Daddy, that was her. At her PS, she'd managed to pick up a reputation for having picked a fight almost every single day. She'd even

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managed to rearrange the class pretty-face.

Lemon stared glumly across at Santos, thinking it really could have been worse. Ten people in a two-room shack that made slums look beautiful, wearing somebody's hand-me-downs third or fourth in line from big sister who's already pregnant by some rudie gunman who got shot to pieces by pissed-off cops or other gunman working for the other political party. She tried to hold the image and couldn't quite make it. It was easier to envision lousy winters in cities where the snow turned grey before it hit the ground. Easier to bitch about the lot of the common city nigger. Somebody in sociology had tried to teach her about Marcus Garvey, and she hadn't listened, but she was damn sure Garvey would have been disgusted. Africans and Black Americans were aliens to each other. Neither Americans nor Africans could understand West Indian Rastafari, still hailing His Imperial Majesty Haile Selassie, long dead at the hands of Ethiopian liberators who were themselves long gone, as God on Earth. The shackles of the oppressor shall be thrown off.

She was badly in need of firm, unalterable opinions, wished she had a stand on whaever issues were in favor.

Santos sat up straight, smoothing at her blonde hair with her left hand. She aimed her director rod at the vid display, and the normal visual segment of it vanished, leaving only the computer graphic. New lines appeared on the screen.

"If it's cut *so*," Santos said, "the pop-out should project the segment out to a safe distance, assuming it's not linked to a vibration sensor—I'm assuming that that wasn't considered as part of the final package; too sensitive to things that have nothing to do with getting at the threat. Once it's heading away, it can fire; it won't hurt us. We *might* get a wash of flame, but it won't hurt as much. We can shield for radio."

Another flick of the director and a segmented electronic sketch of Alco Five replaced the detailed graphic, the simplified tubular graphic lying diagonal across the screen. Santos' fingers played the terminal, and a round red node spat from the upper left edge.

"Not exact," she said, "but a reasonable representation. The cutaway area can be protected by flex sheeting. Bubble it up with additional kilos per square centimeter pressure and that thing'll go so fast a blink'll hide it."

"Compartment bangs?" Lemon said.

Santos shook her head. "Shield it. Once it's away, our own standard shielding'll do most of the work."

Lemon nodded. She was beginning to feel a little sneaky about it. "Okay, work on that, and give me a thought-through wargame sketch on it, ASAP. Check everything, make sure we won't screw it up. I wanna go home, but I don't wanna go home like *that*, read through?"

"And cherish, dear."

Lemon noticed exactly how tired and ill Santos looked. It was partly wariness. "Hey, you go grab a relief now," she said. "Work on your back awhile, huh?"

Santos smiled. "I'll do that. *Hélas*,

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to be controlled by the moon. Wolfmen and women."

Lemon smiled slightly. "Sure. I'm winding up—gonna start ripping people up soon."

Santos raised an eyebrow. "You too. I thought you seemed wound up. Explains your headache away."

"Like hell."

"I wonder if Petersen—?" This in a hushed, secretive whisper.

"*I* ain't gonna ask him. No nerve. Go get the hell out of here, Santos. Go weep or whatever you soft women do at these painful times."

Santos stood, stretched, flashed a thin grin at Lemon, and took off. Lemon watched her until the boardroom doors hid her.

"Petersen?"

Petersen looked up from the vid console, and his hardly-touched, mangled dinner. She eyed her own pizza, partly eaten, ready to be rewarmed. Into the microwave oven for a minute, nice and hot. Who the hell, she thought, ever had a microwave oven to reheat the leftovers in Jamaica. Who the hell ever had leftovers? Too wanting for food, dammit.

She said, "Get me a patch through to China One. I want a word with their security director."

"He won't call off the chop-sockies, ma'am," he said, thickly.

Lemon shook her head, burying irritation. "I don't want him to."

"You could have utilized your money to develop a straight campaign," Dayde said. "To build a lobby, to educate the people."

"We have tried," Lindsay said. "We have tried our best. We are *still* trying—people are still trying to educate the common people, and will continue trying after this. But what are the chances of success? Your own people, Dayde, they have a fraction of the audience only. NBC, CBS, ABC once had almost total control in America. Now we can choose from dozens of sources. There is a fight to gather a large audience—and that requires spectacular tactics to succeed. *This*. Dem a run fe see niggerman show—we unload the truth. People are *fascinated* by the potential for blood and violence. Blood a go run, people a go run fe see it."

"This won't do anything for your cause. Even less if you kill any more people. Do you really want to give ammunition to the Klan and the National Front? They aren't dead, Lindsay, they're just lying quiet. My grandpa, he didn't mind wearing a white hood. You do what you threaten to do, Lindsay, you'll see white hoods growing like goddamn corn. You want that? They'll burn you."

"Oh," Lindsay said, with a lazy shrug, "this is only a gesture. A show of force to make someone listen to us . . . the Klan was hurt less by quiet legalisms than by a show of strength, a show of force. Selma hurt your grandpapa, didn't it? Anti-Nazi League displays hurt the National Front's Nazis—the *threat* is there. With the power behind it. We are sick of the quiet approach, Dayde, so we are being flamboyant. Bringing festival."

Dayde said, "It must have cost you

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one hell of a lot to get the bombs and so on together—"

He was fishing, and he was aware that Lindsay knew that: his voice had an unconvincing sound.

"It," Lindsay said, "will cost a *raasclaat* lot to do it again. We work *within*, Dayde. Set up the attention grabber and work from there, back it up. It will take time, but we'll get everything we want. Sometime. Soon. Seen?"

"All of you—"

Lindsay picked up on it for his own purposes. "All of we are crippled men, Dayde. Emotionally or physically. See how them tear out me soul and a set it on fire? My wife put ten years into an art gallery, Dayde, and it *burned*. Them just burn it. No reason. Just to see it burn. Rich man t'ing. Have you ever been forced to *fight* to live? Like walking barefoot through hell . . . backside, na hell dat?" Lindsay suddenly lifted a foot, using the other foot to kick off a plimsole. The shoe drifted away, slowly moving out of axis, slowly beginning the long fall to the ground.

Lindsay held up his bare foot. Pale scars cross-hatched the brown-pink sole. Other scars led up, in thin lines, his leg.

"*That*," Lindsay said, "is when you have no shoe fe run over broken glass and stone. Ewarton na so bad—but bad. The damn Jamaica Defence force, to shit, dem *never* organized, and is *their bumbaclaat* leader fuck off so fast dem such dust. Dem mad dog, mad *maugre* dog, with gun—machine gun, big pistol, rifle. Is me dem shoot-up shoot-up. Tryin' fe dead me." Lindsay's knuckles were pale; he was squeezing the trigger as though he wanted to break it. "*Bumbaclaat* cop and soldier, dem wicked like devil, like devil. Is na me dem dead. Me children, me wife, na me. Is a fuckeries dem a do." Lindsay shook his head. "Is me saved. We tried hiding in the plant at Ewarton, but dem miser bastard na replace security fence, nothin'. All that plant out of date, ten fifteen, twenty years to shit, holding it together with spit and shit after government start fe buy in."

Lindsay fell silent. Dayde said nothing, just watched the Jamaican breathing deeply, his eyes distant.

Suddenly, Lindsay said, "Like all prime movers, Dayde. Those crippled the worst, those with burned souls, they're the most dangerous. Them turn wolf, to *raas*."

9

"Query," Peterson said, staring straight across at Lemon, who looked up from her portaterminal. "How do you get explosive devices onto a flying fack?"

"Smuggle 'em professionally," Lemon said, annoyed, and with her annoyance easily heard in her voice. Huskiness halfway to a true growl, a summer afternoon transformed miraculously into a sawmill. "Stupid question, Jeff. I'm set up to catch amateurs who want to smuggle ganja or tobacco aboard, but this is something else again. Lindsay's been here long enough to have all the components shipped in, with time enough to build the things himself if he had to—for all *I* know, those things have been on board as long as he has. Dozen ways you can smuggle

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junk aboard without getting caught. . . . Christ, I used to hang out with sons of bitches who could smuggle any*thing* any*where*. And Lindsay's got an organization behind him that's probably going to include at least one talented pro smuggler—Jamaica used to breed 'em both ways. The thing that's got me sweating is that thruster."

"Easy enough to orbit it," Santos said. She was looking less tired now, far less haggard, but still strained. Just like life to pile everything into the middle and stir it up. She wished Lindsay had waited a week, or that Dayde's visit had been a week further along the schedule. "All it takes is an OTRAG cheapie slide-stage booster and somebody to scooter it at this end to get it in place . . . getting a discard unit isn't hard. Give me a few people who're patient enough to put up with some work and a lot of fiddling, I can pick up a discard in orbit and get it functional long enough to do the job."

"Okay, but why the expense? Why bother? The threat of vacuum's enough for us. That gets us where it *really* hurts us—"

"It makes it certain, for one, and it scares a whole lot of other people besides us. Meaningful people."

Lemon's small hand smacked reinforced teak with a pistol-shot sound, making Petersen jump and flinch. "Or maybe everyone's being psyched." She sat back, looking from Santos to Petersen and back, her scowl fully in place, giving an impression of thunder coming. "Like the old unloaded gun trick, the wooden gun bluff—goddamn it, it's the *threat* that counts, the bluff. As long as we believe in it, we're paralyzed."

Santos raised her eyebrows. "Can we afford to check it out?"

"Right!—You got it, *buzha*. I've got odds that it's fake-out time, but we can't even *twitch* to check it out."

"Lemon," Santos said, her voice unusually mellow.

"Huh?" Lemon said.

"One thing to add to your assessment."

Lemon shrugged. "So say it."

"Russian roulette."

Petersen was studiously watching his terminal display.

10

"Okay, ma'am, here's where we go in."

Alayne Keyes Uhola, chief structural maintenance engineer for Alco Five, touched keyboard segments, finger-speaking to the computers that managed to simplify his job. Normally, he would be concerned centrally with modifications and maintenance on the main alumina processing unit—the thundering great lump of metal, as Lemon had heard someone refer to it, that was the main danger from a factory dump.

An inset section of the wallscreen showed a somewhat complex segment of the mass of computer-stored blueprints for Alco Five. Some structural modifications had been made during the course of construction, and further modifications, complete changes, and additions made afterwards, all for practical reasons. The changes were laid out in an intriguing selection of computer-generated colors. The segment dis-

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played included an airshaft entrance. In response to Uhola's instructions, the computer picked out the entrance, magnified it, rotated it ninety degrees in the horizontal plane, then ninety degrees vertically, after which it tracked the blueprint-shaft to its next vent point. Figures beneath the blueprint display gave dimensions, material strengths, stresses, more, very little of which Lemon could read, never mind understand.

Uhola said, "Lindsay's dangerous, you know. He means it."

"One of your people," Lemon said.

Uhola shrugged. "Depending on the sense, Ms. Hayes, one of yours too. Good projects man, though."

"Think he knows enough to mine the place?"

Uhola drummed thick fingers on the casing of his terminal. "Basic knowledge and enough sense to ask a computer. The machinery here keeps constant track of *everything*, it has to. Anything serious happens, we must be able to get at it, at the information, fast. That's the problem, really. Common people can do the job."

"Uhola," Lemon said, trying to avoid showing suspicion with her voice, "you on his side?"

"He doesn't pay me," Uhola said.

"Uh-huh. That bitch up there's a nigger like you and me, Uhola, and my folks're migrants. And you're Third World."

"Does that make me a confederate of terrorists?" Uhola said. "I had a good education, a good university—"

"All the friggin' niggers go to Oxford," Lemon growled.

Uhola grinned. "*All* right, Ms. Hayes. My point is that I never starved. I don't empathize with him."

"What my mama calls an uptown baby. Goddamn bourgie—middle-class blacks."

"That's the way it goes. *And* I wish him luck. I haven't seen any happy black countries holding out open arms to their bretheren."

"Poor Garvey," Lemon said.

"Ah. Yes. I'm told Ethiopia refused to let Jamaicans in at one time."

"Pilgrimage to Selassie the First," Lemon said. "King of Kings, Lord of Lords, His Imperial Majesty. Got talkative parents, too, never let me forget where they came from. The Rastafarians wouldn't believe Selassie was dead after the Ethiopians killed him—God can't die, see? Crazy cult. Nigger hippies, somebody called them. Used to grow their hair out, get it all matted and tangled, smoke ganja all goddamn day, make the women do all the work."

"Doesn't take a cult," Uhola said. 'I used be tough razor at one time, wild rebel youth—the usual. See the men sitting around all day complaining how hot the sun and how suffering they are. The weight of a domino or a beer bottle is a *terrible* thing." A sour laugh. "The women break their backs. Then again, I haven't seen so many societies without a lazy benchload of men. Primitive cultures are motivated by survival—everybody pull together, hard, or else. No beer bellies in Masai country!"

"If we can get away from our humble origins," Lemon said, with more pati-

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ence than she felt she had, "how about this? How many people do we have who can fit down there?"

The inset image started tracking the blueprint shaft back to its start point.

The main section of the screen showed the progress of the main factory activity for the moment—the cutting away of the hull section bearing the thruster. The work area was hidden beneath a huge bubble formed of multiple sheets of strong plastic inflated by increased air pressures. When the segment was cut free, it would be propelled outwards by the high pressure—several dozen atmospheres pressure once the work team was free—and the bubble would invert, forming a blister on the hull and protecting Alco Five's inhabitants from potential air loss. Lemon hoped it would work; Santos had assured her it would, but Lemon now growing extremely touchy, suspected her aide of trying to ease her fear.

Uhola was drumming his fingers on his terminal again, trying to avoid looking at her.

"Well?" she demanded.

"I ran a check myself. Through all onboard personnel files, medical files, what have you." He looked mildly embarrassed. "Well . . ."

Lemon felt a little weak. She was almost beginning to regret looking for options to try out. "Okay, so go on. Tell me the awful truth, if it's so awful."

Uhola made a show of studying the terminal, fiddling with it. "Well, Ms. Hayes, looking at it, you're the only person who has dimensions to match *those* dimensions. You're the only one who'll fit into the shaft, excepting a robot. And it'll be tight enough for you."

Lemon looked down at her hands, with a creeping feeling of dismay taking the place of frustration. She was so wound up, too, that she wanted to scream, or punch something, but she discounted that, or tried to.

She looked up, saw Uhola watching her. "I used to be a real rough little shit, Uhola, and I bet if you asked Keri Santos, she'd say I bitched all the way here. Well, ain't now that's the time to stop, what d'you say about that?"

He shrugged. He was good at shrugs, Lemon thought, a real noncommital son of a bitch. "Your business. It's a very wild job, though."

"It's a job," she said. "I've never shucked a job yet, and I can't afford to start now, can I? I've worked in hellhole positions before, Uhola, I'm used to it. If I've got another goddamn hot-wall job, too friggin' bad, I've got it."

"You're in charge, ma'am."

"Damn right. So tell me how I get ready."

11

"Ready to pop-top on your goody word, ma'am," said Charlie Subitsky, the project supervisor in charge of the hull-cutting operation.

Lemon looked up and around at the intercom, pausing for a moment before tossing aside one of her scraps of duty uniform. She let go of the piece of cloth with an absent thought that she hadn't got that much to display to the world anyway. *Anything over a handful is wasted*, she recalled, and managed both

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a growl and a grimace. Across the back of a chair was the heavily slick coverall Uhola had had Engineering make up—it was heavy cloth soaked to dripping with either grease or oil. Uhola had promised to fire her along the airshaft like a fresh mango seed squeezed out of a fist.

Lemon, for all Uhola's descriptive powers, couldn't remember ever having seen a mango, never mind a fresh mango seed.

On the bank of vid monitors, Lovell Lindsay was still talking. Lemon had long since stopped listening; the man was now excercising variations on the central theme, amplifying his remembered visions of Armageddon with little details. It had become very obvious that Lindsay was only the pawn, and that he knew that and was happy to be the pawn, the front man, the political black man/common man image to attract the sympathy of the rich, easily guilt-fed masses of the major political blocs. The prime movers were playing a more subtle game in back of him, invisible, pulling strings.

Lemon shook her head, irritated and morose. She was glad she didn't have to face her parents . . . even so, who would feel the worse? Her father had told her how migrants were attacked, how the equation of migrant with evil had been rammed into the conciousness of his country by the government's propaganda machine, even while that same government was allowing its country to go to hell. Massive boosts in funding for the government propaganda department, her father had said, even while funding was being cut for police and school places were being slashed in number and the country was drowning out from massive, unexpected rains.

He'd blamed manipulation: control by the political blocs of the time, and background direction by money people. All without any sort of focus. At which point he'd run. He had never gotten over the guilt feelings, and if it hadn't been so expensive by that time, he might have drunk himself to death. Instead, he'd only had a good try at it.

She watched Lindsay, still looking amiable, if a little tired. She was trying to cut the thread that linked her world with his, trying to declare herself forevermore a part of the society he was trying to force into listening . . . or perhaps she was beyond that.

She wished she could think so, but it wasn't far from there into a cause of her own—causes happened to everybody eventually, if not in youth, in middle age. A cause might die because it achieved its objective or missed it by so far it could regain a fair stance, but there would always be another cause ready to replace it.

She turned her head to look at the big boardroom screen. Displayed on it was the rounded plastic expanse of the bubble, with several work-suited figures surrounding it, their equipment nearby. She watched the screen for a few seconds, wondering whether to call a halt now, whether to bide her time and hope, trying to wait Lindsay out. . . .

No.

"Blow it," she growled.

"Yes ma'am," Subitsky said. Fain-

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ter: "Release it, you guys. Let 'er roll!"

The plastic bubble flexed and flapped explosively as it everted, the multiple sheets effectively plugging the immense hole. The group around it reflexively shifted away as the sheets tightened.

"It's gone!" Petersen yelled. There was more shouting from the communications desk—Subitsky getting his people to check for faults.

Lemon fought a losing battle against the tension that threatened to leave her with a combination of nausea, stomach pains, cramps, and a replay of her headache; she was waiting for an explosion, a flare of flame, destruction, tensing for pain. Waiting in vain.

Santos switched quickly from interior cameras to exterior, triggering her computers into a pre-programmed series of actions. Multiple insets on the screen showed the trajectory of the cutaway, visual kept track of the chunk. The cutaway had blown free a little awkwardly and was tumbling as it rode its course away from Alco Five.

There was a twin silver-orange-white flash and flare across the screen as two Chinese hunter-killer satellites vectored out of the orbits they had been sitting in for the last few hours and went chasing after the segment.

There was a sudden, frightening explosion of fire, brilliant, blinding, and Lemon shielded her eyes, terrified. Petersen was swearing, Santos was swearing.

The Chinese hunter-killers hit their target positions and unleashed a crisscross complex latticework of laser and charged-particle beam fire.

The thruster exploded. A piece of metal thirty centimeters across slammed into one of the hunter-killers, reducing it to hurtling, tumbling ruin.

Santos muttered, "Some debris on its way." She hit out. "Subitsky, guard your fanny, metal rain's on its way. Watch the bubble."

The remaining hunter-killer chased an amorphous mass of debris a couple of kilometers further before a couple of kicks from its jets put it on a different course.

Lemon shook, slowly getting herself under control, after which she untensed so rapidly she felt like she was a broken rubber band. She wanted to scream and she wanted to cry and her hands *goddammit* wouldn't quit shaking. Petersen looked as though he'd been given a cure for terminal cancer, but then he was up and racing for the johns. Santos just couldn't speak. She sat behind her terminal and looked as though she had been stabbed in the gut, and, Lemon thought, more than likely she felt like that too, what a hell of a time to have anybody do that to a flying fack.

She managed a distraught look at Santos, and then, still trying to look proud and cool, went running for the johns after Petersen, not sure whether she was going to throw up, start sobbing, or what.

12

Entry into the airshaft system wasn't easy—the maintenance engineers first ripped out a grill to check access, then had to tear out half a wall to get at the widest part of the shaft. At the far end of the run—or crawl—Lemon had to

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make, the grill was regulation size, wide enough for her to go through, but at the starting end, the shaft had been tapered before it vented. Building problems had created a need for sharp on-the-spot design solutions.

In addition to ripping and gouging their home and job security, the maintenance team would have to sit on coals until she was clear, controlling airflow manually, temporarily jinxing the series of decompression gates. Her presence in the system could cause fatal malfunctions, though the barrier system would continue to work on an emergency basis: if a compartment was blown, and she was past the requisite gate, they would have to pull her corpse out as part of the emergency job.

It wasn't a thought that cheered her very much.

It just had to be done, and she was the one stuck with doing it. If she was killed, and Alco Five survived her, somebody else would be scootered in to replace her. She was expendable in the extreme, and also *very* handy.

Once she was out of the system, she could suit up, but until then, she was vulnerable. And she didn't want to go. But she was going.

She made one last check to see that her canerows were staying in place—she wasn't going to suffer the indignity of a shaved head—then allowed the engineers to hoist her into position. She had a moment to orient herself before she was eased into the airshaft. Small as she was, it was still damn tight, and moving was going to take some effort. Someone attached nylon line to her right leg and foot, then pushed her completely into the shaft, into claustrophobic darkness and ashen oily smells. She wanted to crack a dirty joke to Santos, but felt too lousy to bother trying to think up something strong enough.

She wished she could turn her head to look back, but trying to do so only increased the pressure on her body. There wouldn't be anything to see anyway. *I don't think I like cold dark places.* It felt like damp bedsheets, and the greasy coverall was uncomfortable against her skin, sickening.

So move out you inkydinky mantan-black, TCB.

She planted hand suction cups against the bottom of the airshaft and pulled herself forwards, further into the oiled darkness. There was a hum of machinery around her, a physical whisper of her world, living.

Ping in her right ear.

Her world tried to scare her silly.

"You okay, Ms. Hayes?" Petersen asked.

Christ, you suckass fish. She slowed her breathing and tried not to cough as the dust tickled her throat. The smell of free dust was hard, threatening an allergy headache. The throat-boom itched, the mikehead tickling her lower lip.

"I'm fine," she said. "How's Lindsay?" Pull on, slide. Torpedoes had a fine time in their tubes. "He realized his big bluff's blown yet?"

"Not yet. I don't think even Dayde's noticed."

"Don't tell him,'cause he givin' the finest of his *life*." *Keep going, Mama*

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Midnight, not so far to go. She scraped by a decompression gate, the coverall saving her back from a painful chafing.

"Read," Petersen said.

"So shaddap and let me crawl. Let Keri monitor. Santos? You listening, Ace?"

"Listening."

The silence after that was close, but comfortable.

Her arms were starting to get tired. Turning over and backsliding might have been some help to her, but she couldn't turn. The airshaft was built on a rectangular pattern, and once in it, she was stuck. She could be pulled out, backwards and embarrassed, but that was all. The rope was a welcome pressure on her leg.

She tried squirming forward, using her feet to push. She could hear her breathing, close, sharp, and reflected, almost like living inside an assembly suit, tin can codified. There was the hum of machinery, too, to fit with the solitary movement: metallic counterattack.

It was almost impossible to attempt any sort of power crawling; small she might be, but it was a long time since childhood, and she was shaped African, big hips, big backside. The job was suited more to a true child, or a midget. Maybe if she put in a request document for a supply of security-trained Munchkins. . . .

She almost giggled, barely managed to control herself.

She slid on, dripping sweat that salted her tongue and stung her eyes, exposed skin feeling sore, hot, gritty, the surrounding atmosphere feeling wet and stuffy, dead; her mind was starting to get a little muzzy. The slick coverall still felt cold and clammy, an oily burial coat. Breathing was an ongoing battle with total frustration and slow choking, filled with sweat and heat and an itching stink of oiled dust.

She hauled herself onwards, mind blank.

"You okay, ma'am?"

"Petersen, shaddap you excuse for Sylvester's mama. Goddam."

She was surprised by the cold fresh air that flooded into her face. She could see low light ahead, filtered by a grill, and that woke her up completely. She sighed with relief and laid her face against the bottom of the airshaft.Cold, but good. The space between her skin and the coverall was filled with sweat, and she felt itching wet.

She rested for a minute before feeling out the grill. She would have to risk scratching herself on the way out—using a microlaser to cut the grill might trigger any of the devices present in the compartment. Instead, she had to use a small mechanical cutter; it took a couple of minutes to cut the grill loose—orbital manufacturing facilities were built to last, with the best components available.

Finally, she was able to bend the grill up by one corner, out of the way. She would have preferred cutting it completely free, but she didn't want it bouncing around to trigger something.

She said, "Get that damn rope tight. Here I go."

The rope tugged at her heel, and she

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locked her ankles. She hesitated a moment, stomach tight, before bellying forwards into open air. It was like going into the icebox after a hot shower, or coming out of a moviehouse into a winter evening; sweat trickled ticklishly in places she hadn't known she had nerves.

Hands on the wall, she shoved, jackknifing out of the shaft before she could change her mind about it. Her greasy coverall complained and frayed where the sharp-edged grill wire snagged it, and she swung free momentarily before beginning the swing back into the wall, the rope jerking at her ankles. Impact with the wall was mild panic and painless, and she quickly slithered down the wall to floor level, landing neatly on her hands and falling automatically into a crouch.

"Born again, Ace," she said. "I'm down."

Ping. "I needed the joke. How's it look your end, dear?" Santos. Good.

Lemon untied the rope, and glanced around in the low light from the safety fluorescent, noting the few distinct objects. "Empty storage unit." She gave some details.

"Hold unit eleven-four-A, material storage and ancillary usages, alright, you're in the right place."

"Glad to hear it." Lemon coiled the free end of the rope in her hands. "I'm pulling for a suit and tools, okay?"

"Pull away."

She started reeling the rope in, her back stiff. Things usually went all to hell close to victory. . . . The nylon line suffered the treatment well; it had been designed for far worse use than this. Lemon was surprised at how long she was pulling before the first pack appeared and snagged on the cut grill—she'd been crawling through the shaft for far longer than she had thought, probably with a blank mind most of the way. No wonder Petersen had been fretting.

She worked the pack loose, cautiously, and caught it neatly as it dropped—she hadn't been much at streetball, but then, her life had never depended on catching a frayed baseball, at least not as much as it depended on that pack. It was her suit, neatly packed; if anything went bang, it might save her life long enough for a rescue team to get to her. The techs who had died in the two earlier blasts might now have been alive if they'd been wearing suits, but who ever wore a spacesuit in a shirtsleeves environment?

She stripped off the clammy coverall with relief, and was surprised by the amount of sweat that ran off her oiled skin, and had to try squeegeeing herself with her hands before climbing into the spacesuit.

Once in the suit, she tied the coverall around her middle, in case of shrapnel, and to ease her mind a little. Another haul on the rope, and she was gifted with tools. Another pull, and she had a video setup—camera, mount, transmitter unit, and return monitor.

She took a moment to calm her hands.

Santos said, "I hope you aren't prone to nerves, sweetchild."

Lemon felt insulted and a little hysterical hearing that. "Not much . . . you

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can sell your sugar on the street, and *goddamn*, you keep talkin' like that I'm gonna die of fright—" She wondered whether she'd hear the explosion.

"Just keep your hands steady, Lemon," Santos said, smoothly. "And listen: I sell it on the street *only* in New Orleans. Bayou blood, get some of that Cajun spirit. Okay, set up and give me a look at everything in there—the whole load, *shiksa*. If Lindsay's using a transmitter, something in there is acting as a receiver, or should be. And maybe decoder and selector as well. That TV thing of his is just a little too big for my taste—he'd really be better off with something smaller. I think he's hauling around a transmitter as well, with selector—punch the numbers stuff."

"Oh. I never thought—different frequencies involved?" Lemon unshipped the video equipment, activated the rig, checked that there was a picture coming through. She used the shoulder mount first, turning slowly, scanning everything. It occupied her mind and calmed her nerves a little, eased her.

Santos said, "I thought about it . . . poss, but *not* likely. Multiplex coding at the outside. More likely just a number code so he can trigger individual units to make us jump. The decode circuit comes at the bang end, so these things probably have microprocessors built into the receivers. Ah, camera is good, no QRM. To go on: if he wants to set everything off at once, he'd have a secondary code, an override common to everything. Saves him messing around, hence the squeeze trigger. All makes for less chance of accidental bang which he wants to avoid."

Lemon paused in what she was doing, which got a grunt from Santos. "All that sounds real wonderful, Keri, but I'm *still* scared shitfree." She could feel sweat, again, the small of her back.

Santos set to work, directing her, and had the receiver unit pinpointed in minutes, with the help of a good computer. More directions followed. Lemon set the camera up on its mount, aimed where Santos wanted it aimed, and got to work with tools she had never seen before. She worked with frightened fingers, gingerly, afraid to touch anything, waiting all the time for the explosive thump that might mean the end of her life. She felt like a frightened automaton, Santos' organic, long-distance remote-controlled hands. Not that it could be helped. Santos would have preferred an explosives expert, Lemon knew that, but she'd had to take what she'd got. Lemon only knew security and management; Santos was more of a pro security agent.

Suddenly, Santos crowed, "We've got his frequency!"

Lemon leaned back, carefully, putting equipment back into her kit, careful what she touched. She didn't exactly feel triumphant, just blank and frightened. Her mind was cottonwool. "So?"

"We can jam him. He can't blow holes in us by choice. He can't blow holes—we're safe, to some degree."

"By accident . . . oh yeah, Keri, I'll pick him up myself. I want that." She licked dry, salty lips. "Everybody else better leave off 'til I get out there." *Strike back mantanblack tiger-gal. There*

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goes that complex again.

"I guessed already, *shiksa*. Okay, now let's have a look at his explosive rig."

"Where?"

"Behind. Hull proximity."

Lemon turned, crossed the hold to the bulkhead that was the barrier to hard vacuum. Triple-layered and tough as Beelzebub's tail end, it could still be ripped apart by a good meteor strike, or a bombing. She took the camera equipment with her, started making passes over the hull.

"There."

The word left Lemon staring in mild anxiety at a large rectangular unit attached to the metal. She set the camera mount up and left the camera watching the stowaway, going back for the tools. It took only a moment to set up the blast shield—making it portable had called for some compromises, but it would still help. The glove-waldoes weren't as good as those used by groundside bomb squads, but they were good enough for this job.

"Nasty looking device that," Santos said. "Better give me a composition check on it."

Lemon followed instructions to the letter, watching the flow of data on her tool kit's screen without understanding it. It would be fed directly to Santos' computers. The computers would analyze the data from Lemon's scanners and return, she hoped, with the best approach to defusing the device.

Lemon sweated in silence for a minute, already feeling uncomfortable in the suit—without a bodysuit to take the wear, the suit was rough on her skin. She wanted to scratch where she itched, and didn't dare open the suit to do it.

"Give me a rerun on those scans, sweetchild."

"Why?"

"Wanna be sure of myself, come *on*."

Lemon went to work, with a sick feeling that there was nothing Santos could tell her about the device, that she was trapped with the thing on the verge of blowing.

"Give me a straight scan on the hull."

Lemon tracked the scanner over the hull. "What's going on?"

"Making checks. This is *not* goddamn easy, Lemon. I'm scared to death here."

Lemon nearly dropped the expensive piece of equipment she was holding. "*You're*— Shit, you're scared?"

"Yah, yah, yah, *affirmative* sweetchild. Scared. Like you."

Lemon crouched, frozen. "You're crazy, Ace. *I'm* crazy. You trying to kill me with fright or some—"

"No go on the greenlight! You know me eight years, Lemon, so *trust* me. I'm just warning you. *That* is a bitch's bastard piece, you don't see it much, but it's a bastard, believe me. You're going to go at it *verrrry* careful. But, dammit, you'll *do* it. I'm not out to kill you unless you start stealing my lovers, watch?"

"Seen," she said, not thinking. "Daybright."

"Let's go to it, sweetchild."

She got to it.

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She worked in silence for long minutes, trying to avoid getting sweat in her eyes, opening the unit, disconnecting the last cable from the receiver, pulling sensor wires loose. Santos' instructions came in a calm, clear voice, repeated for emphasis. Now and then, a picture would appear on Lemon's video monitor, showing her what to look for, what to do.

"Almost there," Santos said.

Another instruction.

Lemon went to work, slowly, carefully.

"One more step to go, sweetchild. Want to take a breather?"

Lemon waited. "No. I want to get out of here."

"I want to get you out. 'Kay. Number-two-with-the-sharp-end. Got it?"

"Got it."

A picture flashed onto the monitor.

"Follow that," Santos said. "Bloody carefully. Slip and you could blow it."

Lemon watched the monitor, absorbing three play-throughs of what she had to do before going to work. She worked slowly, carefully, with all the patience of a jeweller, a watchmaker.

There was a sudden, cramping pain in her belly. She tensed automatically, making only the slightest of motions, but she was wearing the waldoes, power-waldoes.

There was a brilliant flash of light that almost blinded her. She didn't remember hearing the blast; it was a shaped charge. There was pain at her hands as the waldoes were blown away from the device, and a solid, agonizing impact at her stomach as something came through the blast-shield.

She snatched her hands out of the waldoes and curled into a ball, cursing and screaming. She heard Santos calling her name, but couldn't answer. The outrush of air pulled her up and out, and she kicked, frantically, to aim herself at the broken wall. Metal gave as she hit it, but stopped her before she was pulled out of the hole.

Silence surrounded her, the silence of vacuum.

Santos: "Lemon! Lemon, *goddammit*!"

She moaned.

"We need somebody in there," Santos said. "*No*, I don't want them to open—dammit, there's a hole the size of a shuttle—yes, that is—good for you . . . jackass. Lemon? Oh Jesus on wheels."

"Ace," Lemon managed to mutter. "Takes more'n a bomb to knock me over."

"Oh balls," Santos said. "Do you have to scare me, Lemon?"

"Yeah."

"We've got somebody coming for you now, but where are you?"

Lemon inspected herself, carefully, then doubled up again, clamping her arms hard across her middle. Her voice was strained when she spoke. "I'm still inside, Keri. Bounced me off a wall, is all. Got something right in the middle, too."

"Hurt?"

"Don't come on so goddamn motherly, dammit! No. Ripped suit. Look like I've got gutsache."

"What the hell happened?"

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"Cramp. I twitched. Goddamn waldoes picked it up."

"Oh my gawd. *You* are lucky there wasn't silver in that thing."

"Ha goddamn ha friggin' ho. Your mama too, Santos."

A light flashed around the edge of the ragged hole in the bulkhead. A spacesuit helmet—a proper EVA suit this time—appeared, headlight blazing. Another helmet floated past the hole on the opposite side.

"*Hey*!" Lemon yelled.

"Ouch," Santos said.

"Ms. Hayes?" a man said. "Hannau. You okay?"

"Do I look it?" she growled.

"Yeah. Uh . . . O'Hara, better get the bag ready. Busted suit, ma'am?"

"You got it. *The* bag?"

"Yeah. Come on, I'll help you out. Free ride, huh?"

"Sure." She snorted. "Home in a goddamn doggy bag."

"Better than a body bag," Santos said.

Lemon clammed up.

13

"It comes down in the end, doesn't it, to whether I want to be known to the future as a callous mass-murderer: a junior Hitler or Jim Jones or Idi Amin . . . or whether I want to be envisioned as a martyr."

"I'm wondering myself whether you can justify either mass murder or suicide to yourself long enough to go through with it. Your family's not going to come back, and you won't see whether you actually achieved anything if you kill yourself."

"I probably won't see a damn thing if I live," Lindsay said, quite reasonably. "Is a damn screwface you'll see toss me in lockup widout key. Bread and water fe life."

Lindsay's hand rose into view on the vid screen, and in it was the dill pickle shape of the squeeze trigger. To Lemon, the gesture now had an air of abstract surrender, an essence of futility.

"Oh," Lindsay said, "I may threaten, but I'm not really a killer . . . my instruments are real, they *must* be real. But death frightens me . . . all the more for it having been so close to me. I prefer gestures, but sometimes gestures are not enough."

"Is there really any threat?" Dayde asked.

"Oh yes. Difficult to counter."

Oh yes, Lemon thought, *but we've got you now*. The massive bruise across her stomach wasn't crippling, just damn painful, and she didn't think she'd be trying to lay anybody for at least a month. *We and we pain, sistren all*. Oh, yes, there was a threat, but Santos was dealing with it.

"Actions such as this," Lindsay said. "There's a threat *beyond* the appearance, far beyond it. The continuing threat is that it might be repeated, no matter the precautions—when skyjackings began, you remember, all airports had a thousand ways of finding terrorists, who still managed to hijack planes. This is *our* threat. If I fail, where might the next attack take place? And will it succeed?"

"You check out, ma'am," the sports tech said. Lemon flexed her wings au-

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tomatically in response, finding them fully comfortable. The presence of axis, where things remained in free-fall, unaffected by the factory's slow rotation, had made development of new sports possible—including man-powered flight, using newly created toys. "Careful jumping, though. Those claws can make it real touchy. You sure you'll be okay out there?"

Lemon sighed and turned the vid off. "Tell Keri it takes more than a punch in the gut to stop me. Ain't needed *my* mama since I was fourteen." She flexed the waldo claws attached to her feet; they were a straight sports item, used in axis games to carry wingballs and paddles and whatever else was in use. If a player went out of axis and needed help, the claws came in handy.

"Okay, ma'am," the tech said. He scratched his head. "That when you got laid first?"

"Where the hell'd they get you from?" she said, grinning. "Aspen?"

"Vale. I hate skis. Don't believe what they say about the women down there. Ain't true."

"Yeah."

She checked the Taser rig attached to her left wrist, checked her wing balance again—only a hatchee plunges straight out without multiple checks—and stepped carefully to the end of the narrow axis eyrie platform, hooking her claws around the edge to hold her in place. She took a deep breath, looking out along the colorful beauty of Alco Five's living area, to the dark points floating at midpoint.

"See ya!" she called to the tech.

And she launched herself out into the weightless flying space of axis.

14

They hung at midpoint, Lemon facing Lindsay, Dayde a short distance away, camera on them. Lemon drifted with eyes sharp on Lindsay, trying to remain as unemotional as possible.

"You're finished," she said.

"So them send *nayga* dog fe *nyam* old bone," Lindsay said. "I trust it was difficult."

"You killed five people." Lemon said. "You nearly killed me. And you caused several hundred thousand bucks worth of damage—that's a guess."

Lindsay shook his head, sadly. "For the sake of my message."

"It didn't go outside of Alco Five," Lemon said, each word sharply phrased. "I made damn sure of that."

"Oh, Ms. Hayes," Lindsay said. He shook his head again, smiling. "Do you put that past us too? *You* know I have backing."

She turned her head, to look at Dayde, suspicious.

"No," Lindsay said. "Not Dayde."

"I've got a bruise in my gut that makes me suspicious," she said. She looked back at Lindsay. "You're under arrest." It didn't sound right to her, it wasn't strong and commanding enough. *Your rights are as follows*—It just sounded exhausted.

"You na Babylon," Lindsay said. "Police, that is."

"I know. My folks're Jamaican."

Lindsay laughed, racking himself. Lemon raised the Taser, waiting.

Lindsay lifted the television unit.

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"Keri!" Lemon shouted.

Half-a-dozen brilliant red flashes followed her shout, and smoke erupted from the two things Lindsay was clutching. Lindsay howled in pain and hurled the portavid in one direction, the remains of the squeeze trigger in the other.

He jackknifed before Lemon could move, and dove. She fired the Taser, and missed.

"Lemon!" Santos said, in her left ear. "Suicide. Leave him!"

"*No*!" she screamed.

She ripped the Taser off and hurled it away, jackknifed, and dove, wings beating. Lindsay was trying to fall on a straight course, but the rotation of Alco Five was making his course curve a little. His velocity wasn't very high yet; the pseudogravity wasn't very high this far from the ground. She aimed to intercept him.

He suddenly swooped into level flight, going against the rotation of Alco Five; he went up, away from her. She spread her wings as far as they would go, went after him, banking and swooping upwards. The massive bruise across her stomach hurt like hell.

He jackknifed again, folding his wings. Lemon couldn't see what he was doing, what he was trying to do. She went after him again, an eagle hunting a hurtling bat.

His wings suddenly peeled away from him, released. He'd worked out that he'd fall faster without the extra drag of the wing surface. He'd been releasing the harnesses in level flight. . . .

"*Lindsay*!" she screamed. "*Lindsayyyyyy*!"

Her cry was borne away on her slipstream.

Lindsay fell, going away from her, and away. Was gone.

She spread her wings, cried out with the strain it put on her stomach and her bruised hands. She got onto a level course, banked hard, going against the rotation of Alco Five. Her eyes stung. No chance of getting back up to axis now.

Down.

Slowing, she fell.

She managed to hold her panic in, scanning the ground area below her. Company town. If she wasn't careful, she was going to come down in a shopping area or a field or something and kill herself.

Why the hell did we have to scare Lindsay with the lasers?

The slipstream tore at her. She turned the undersurfaces of her wings against her path, slowing herself before banking. *Where in hell is that lagoon*?

She gritted her teeth and tried to breath.

A flash of water. River water.

She banked to follow it, tilting in her course to fall a little more. Difficult to fly now, with wings. Pseudogravity was getting too much for them, no matter how much her strength was amplified, no matter how good the design, how big the wingspread.

She wondered where Lindsay had hit.

Water flashed well ahead of her, a big mass.

I'm gonna bash out my brains on

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coral.

A hundred meters still to fall. She aimed herself at the lagoon, correcting for rotation and velocity, and dove, wings at ninety degrees to her plane of flight, correcting quickly to prevent a fatal stall, until the last minute.

She deliberately stalled, directly over the lagoon's edge. She folded her wings as she went, kicking away the waldo claws. She went down across the lagoon like a missile.

The water was like a brick wall, but she wasn't aware of that for very long.

15

Dayde said, "Ms. Santos says you should make *Guinness*. Alongside Merriman."

Lemon glared at him. She was uncomfortable as all hell, swaddled in plaster and bandages. She had been dragged out of the lagoon seconds after hitting it, but water hadn't saved her from cracked bones.

"You," Dayde said, "are also something of a media heroine. How's that sound?"

"Don't bend over."

Dayde grinned. "Thanks. I get that for helping, huh?"

Lemon said nothing. There was an old Ron Carter tape playing through her room's quad system, and she really wanted to listen to that. Business called, instead. She listened for a few moments to piccolo bass complications and weavings, lazy jazz for sweet sugar people. At least nobody had demanded a full report from her yet.

Dayde said, "You wanted to see me."

"Yeah. You were recording up here."

"Doing my job."

She raised an eyebrow. Even that felt sore. What annoyed her most was that, despite this being her own apartment, the place stank like a hospital.

She said, "Got the cubes?"

"Never let them out of sight."

"Okay. I'm going to bring a video editor in here, and me and you are going to go through those things and make something professional out of 'em."

Dayde looked at her, curious. "We are?"

"You don't want to pick up that Pulitzer?"

"Screw the Pulitzer. You on Lindsay's side?"

She couldn't shrug. "Let's just say my job is security, okay? I don't want this to happen again. Might succeed next time. Might make *nigger* a dirty word again."

"My shuttle leaves tommorow."

"Screw your shuttle, Dayde! You're staying. You're gonna do this goddamn job first. *Then* you can haul your ass out of here. Got that? If you don't, I'm gonna slap a security sticker on you."

Dayde raised his hands. "Okay, okay. I get the rights. You can't take a credit. You aren't union."

"Screw the union too. Get the goddamn job done. We paid for you to come up here. You're goddamn Johnny-on-the-spot, and it's up to you to make money out of it, got that?"

"Yeah. Can I got get lunch?"

"Go on, I don't care."

Dayde left.

Lemon settled back in her bed, star-

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ing at the ceiling for a moment, tired. *I hope this makes you happy, daddy mine.* She reached out for her entertainments console, first boosting the sound level on the Ron Carter tape, then touching a screen control. Earthview, nice and big on the room screen.

She froze.

She was frightened.

She growled and flicked the switch, making light flare on the screen, turning her head to stare at it.

Earth: first world, new world, Third World.

She shuddered. She'd beaten Lindsay, killed him. The Fourth World had killed him.

She switched the screen off and started crying, unable to stop, but tears wouldn't wash the afterimage away. ■

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A Letter to the Editor

STATE OF THE ART

Algis Budrys

Dear Dr. Schmidt:

Scattered comments, some gratuitous, all entirely personal, on matters raised or referred to in the April issue:

In my experience with John Campbell, which includes thirty story sales and a proportional number of conversations between 1952 and 1959, he came not to rely on the AnLab as a gauge of bonus payments to authors. Although he continued to make Lab-mandated payments, he also scattered in others on acceptance. For example, I always scored low, as Dr. Bainbridge's study correctly indicates, and John and I knew I always would, although we weren't sure why. From time to time I received an extra ½¢ or 1¢ per word anyway, and I'm sure I wasn't the only one. There was no system; I presume John made his choices on some esthetic basis.

Campbell's complex opinion of the AnLab included an awareness that some of his new authors were making attempts to rig it, for the sake of the bonuses. He began with a grudging hunch to that effect, and then confirmed his suspicions by some method he didn't discuss with me.

It was caught early, and the effect across a field as wide as the Bainbridge study is surely negligible, provided Campbell somehow corrected for it. But of course the effect on Campbell personally was profound.

Another perspective on the An Lab and related matters

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I think it would be useful to broaden-out the discussion a bit at this point.

During the "Golden Age" of *Astounding Science Fiction*—roughly a decade beginning in 1939—*ASF*, and *Unknown* with it, had been media of expression for an intellectual forum of gentleman amateurs closely centering on Campbell. Campbell saw himself as a Natural Philosopher who happened to earn a portion of his income as a Street & Smith Publishing Company employee. He saw his writers as people who produced fiction only when moved by the inspiration of close interpersonal feedback or by the need of an extra-budget piece of personal property such as a new camera or a vacation ticket. He saw his and his peers' actual full-time occupation as the examination of ideas. The ideas were philosophical; genuine hypotheses, most preferably technological ones, embodied in fictional speculations.

To this point, I've paraphrased common knowledge. But now let's look at what this means functionally.

The hypothesis is what would be most ratable. It would be the thing hammered out in the discussions preceding its embodiment in a manuscript, and the thing tested by audience reaction on publication.

Certainly there would be a set of literary standards. They would functionally relate to the clarity and dramatic interest of the presentation; to whether the hypothesis was carried in an effective vehicle. They would all relate to the viability of the hypothesis. Relative elegance of presentation would be seen as an argument for relative elegance of the hypothesis. In other words, good ideas make good stories, so, perhaps, vice-versa.

But the proof of worth would ultimately lie in the essential thing that Hal Clement still calls the focus of "the game"—reader response to the geophysics of Mesklin, to the political impact of the Weapon Shops or of technology-supported miraculous religion, or to the physics and engineering of the Venus Equilateral culture given a technology of gravitics.

Such a situation visibly existed up to the earlier 1940s. The content of such departments as Brass Tacks, Science Discussions and Probability Zero reflects two things: high reader interest in The Game both with reference to specific stories and as a format, and a high proportion of recurrent bylines. In other words, Campbell had developed a second circle; a correspondence forum concentric with the one being held at his desk and in his living room. I don't think it's too great a leap to deduce that the constant letter-writers were also a constant core of AnLab voters, that Campbell felt comfortable with them, and felt he knew a great deal about them because they were like him. They should have been—he was in charge of whose articulations would be positively reinforced by frequent publication.

All of this would have held true only as long as Campbell, *ASF*'s writers and *ASF*'s articulate readers were all inventing *Astounding Science Fiction* together . . . that is, for as long as all the key people were at least post-adolescent

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when the whole thing began; were reasonably well-formed personalities who brought to *ASF* both the common quality of being effective ideationists and the diversity of coming from a number of backgrounds.

This happy cross-fertilization would slow down in direct relationship to the rise in the proportion of key personnel to whom *ASF* was a given.

This concept is still difficult to grasp, because there is still so much emotional loading for all of us in terms such as *ASF*, Campbell, and Golden Age. Yet inevitably the perceived success of *ASF* in the 1940s would give rise to a second-generation cadre of writers who had been attracted specifically to the magazine and its key individuals, rather than generally to a circle of ideationists for whom *ASF* was merely one aspect of a complex inter-relationship.

Inevitably these fresh contributors would not be pioneers and explorers; they would be garrison troops. However loyal and adventurous they might be, they would operate from a fixed base. No matter how closely they resembled the original cadre in manner and vocabulary, there would be major differences between them as a class and their forerunners as a class, and some of the more subtle and profound differences would be masked by the superficial resemblances.

In other words, I don't think all the implications were graspable by the participants in them, any more than fathers and sons truly understand their inter-relationships until after years of mature recollection and contemplation, by which time the events in which they participated are locked immutably in the past.

The takeover by the second generation was accelerated by one dominant factor. That was the dramatic change in SF market conditions at the end of the 1940s, such that many of the Golden Age regulars could elevate or lateral themselves out of frequent *ASF* appearance. Such a discontinuity did occur, with astonishing speed, creating a real "generation gap" in place of the more gradual evolutionary turnover that might otherwise have occurred. Circa 1950, only James Blish and Poul Anderson were consistently present in the magazine with memorable stories in the Golden Age mode. Neither of them precisely fit the template for characteristic forum members; they represent a small, "one-and-a-half-generation" group. (Much has been made of the "absence" of major *ASF* contributors during World War II. An examination of actual issues 1941-45, I think, will show this effect was not especially profound in fact. I feel safe in disregarding it here.)

With pages to fill in the 1950s, Campbell must have delighted at first in the arrival in 1951 and 1952 of a number of eager contributors, such as myself, who had begun reading *ASF* as adolescents and were now, in their early twenties, equipped to write publishable fiction from a base of total familiarity with *ASF*. Yet this would be where the real trouble would begin, because what we were familiar with was what *ASF* looked like to its *readers*. Campbell and we had a mutual vocabulary; in most cases, that turned out to be the only

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point of mutuality.

The thing is, we were professionals. Our technical training, sensibly enough considering our adolescent career commitments, was in the art of writing; we had never trained in anything else of substance. We varied in degree of intelligence and in measure of innate talent, but by definition any of us could flange up some sort of publishable story much more readily than any but the most experienced gentleman amateur. In other words, we combined naivete and enormous energy . . . a construct which, now I look back at it and put it that way, is always hair-raisingly dangerous.

There was another complicating factor which paralleled and reinforced the errors of perception under which we and Campbell had to deal with each other. A professional writer, of course, first looks at the hole in his bank account, translates it into units of negative grocery rather than negative luxury, then converts its dimensions into cents-per-word, examines his market, and then searches for a saleable story idea. That is, in Golden Age terms, he does it *exactly* backwards. This would be the least detectable of all errors, when you and Campbell are sitting on opposite sides of the same desk and the paramount function of that desk is to facilitate the transit of stories into the magazine.

I believe—there is evidence—that of all the post-1951 writers, I was for several years the closest to John. We could play with ideas together. But even between us, there was a certain awkwardness that baffled both of us from time to time. I believe it was because he looked at them as philosophical ideas, and I would catch them and transform them in a manner resembling Golden Age ideation, but he was talking about the real world and I was talking about story ideas. Time after time, we would fish the salmon out of the water together, the wise bear and the cub, and discover it was canned.

Let me put it another way. I knew I was a good writer; that is, I could be counted on to produce work whose median quality was above minimums. John knew I was a good writer, in exactly those same terms. We both trusted me to, from time to time, produce a story that was not only proficient but outstanding in someway, and we agreed that I did from time to time do so. But we very rarely agreed on which of my stories those were.

We both enjoyed talking editor talk; the arcana of that black art were endlessly fascinating to us. Editing is to me almost exactly the sort of avocation it was to John, and in that area we would comfortably yarn away—his were considerably longer than mine, of course—and play. One of the things we played with, to no conclusion, was how come he and I were in constant disagreement on which of my stories were "good"—as distinguished from functionally valid—and how come neither of our opinions was validated by AnLab scores. No matter what either of us thought, I was a consistent 3.

The AnLab was bothering John for as long as I knew him. At first, how-

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ever, it was bothering him only because he thought it was accurately measuring some sort of increasing distance between himself and his readers. From time to time, he considered the alternative hypothesis that it was indicating a distance between his readers and the rest of the SF community. Since the community was growing in size and-weight—in Golden Age terms, the "tail" of miscellaneous competing magazines and non-*ASF* writers and editors might be beginning to wag the dog—neither hypothesis made for equanimity.

To meet competition, the received wisdom goes, Campbell instituted the bonus system based on AnLab scores. This makes a certain amount of sense; it was a way of utilizing a ten percent rise in his overall budget without going to the ridiculous expedient of paying 3.3 cents per word. But Campbell never did pay an across-the-board rate in my experience. He often fudged the word count on short stories so he could voucher more money for them. (The "extra" bonuses came on top of that, when they came.) He indicated stories of minimum acceptable proficiency by sticking exactly to his count system. I could be paid $100 for a 3000-word story one week, and $90 for a 3000-word story the next, and the look on Campbell's face would tell me why.

I think the real reason John announced and explained the bonus system was that he felt he had come to need a quantifiable means of comparing reader tastes to his own, and of communicating reader tastes to his writers in a meaningful fashion.

This would be a tacit confession of profound changes in the nature of *ASF*. Apart from the obvious ones, it would indicate an awareness that he could no longer speak to all his major writers face-to-face—that some of them were total strangers; impersonal bylines on manuscripts delivered by messengers from literary agencies. These were people with whom he had never so much as exchanged some of the famous Golden Age letters which, for instance in one famous case, had made a top-rank writer out of the young Isaac Asimov. He was sending those strangers a message in the language of professionals—money.

He knew what professionals were. He had encountered them through his many connections with the other Street & Smith pulps, and he admired their skills, as skills. He knew what professional editors do, and he was trying his best to act like one, needs must. A measure of how he basically felt about that can be deduced from the fact that when he found a writer he liked and respected, he did his best to persuade him to turn amateur. He cited rational reasons, but the look on his face was the look of a man counselling amputation to a close relative with gangrene. Money wasn't supposed to be income. It was supposed to be scores.

All right, let's look at the situation in, say, 1954. By now the *ASF* readership contains a high proportion of second-generation readers, for the same reason that a cluster of second-generation writers had appeared. Many of them would be technologists, of course.

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All of the would be idea-buffs. But an increasing proportion of them would be Liberal Arts graduates who would be as appreciative of story technique as they would be of the natural philosophical ideas reflected in the speculative technological propositions.

There is some direct evidence for such a change in the makeup of *ASF*'s readership. As the regular correspondents moved out of Science Discussions and Brass Tacks, either by concentrating on positions of increasing responsibility in their "real" jobs, by attempting to pursue careers as writers, or through ordinary attrition, they were not replaced. Probability Zero had to be dropped because of lack of submissions. Science Discussions had to be killed for roughly the same reason, and Brass Tacks became far less devoted to specific comments on speculative technologies in the stories.

What about the AnLab? I think the composition of its cadre of respondents would also reflect such a change, but more slowly.

Why? Because they were people habituated to AnLab voting. They might no longer have time to write long letters of comment, or departments to which to submit other long forms of expression, but they'd still have time to drop a postcard in the mail. It would be psychically important to them to maintain at least this much personal contact with *ASF* and with what *ASF* meant to them. Meanwhile, the new kind of reader would not be as inclined to vote. For one thing, *ASF* no longer had as many feedback interfaces. For another, esthetic judgments are not readily ratable. It can be done, provided one can get around the basic contradiction between esthetics and numerics. Other magazines had such departments . . . all of them as wan and tendencious as the AnLab also eventually became.

I think it's reasonable to conclude that in, say, 1954, the AnLab was several years of evolution behind the actual readership. Worse, from Campbell's point of view, it was out of phase, in the other direction, with his ideal readership. He had always edited *ASF* and *Unknown* by the seat of his pants, as distinguished from the way he handled *Air Trails* or sat around throwing gimmick ideas to Lester Dent for *Doc Savage*. (He had some beauties; I still know two sure-fire undetectable murder methods he tossed over his shoulder one day.) His growing discomfort at having to change was expressed, I think, in his growing preoccupation with groups of gentleman amateurs outside *ASF*, and, in the magazine, with the crude "reader poll" of the late 1940s and with occasional public growls at the AnLab throughout the 1950s.

And then of course he had the incident about the rigging.

I think this confirmed for John what he felt about professional writers, only worse than he had ever imagined, and I think it contributed disproportionally to the flagging of his elan as an editor. It also showed him that he had, step by step as he made rational decisions about how to use the AnLab, boxed himself in . . . made a bum editorial decision for the best reasons. And of course the

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faceless professionals had sent him back a reply to his message.

Some professionals, of course, were still acceptable; people he could talk to across his desk, people who, like Asimov, Clarke, Heinlein or Anderson had begun as amateurs, and could talk technology from firsthand practice. Right about this time, however, was when he began visibly reaching out for new amateur writers who, however satisfactory they may have been to the *ASF* readership, were not the people who would be anthologized frequently, featured in competing magazines, or offered major contracts by the growing number of book publishers in the market. It seems to me that 1955 or thereabouts marks the point at which Campbell found himself euchred into deliberately departing from the major trends in the SF community, a situation which subsequent editors had to moderate, I am glad to see not to the point where Analog has lost its individuality.

This leaves the interesting question of how he detected the rigging in the first place, and what he did about it.

What he said to me was that some of the ballots were wrong, and not in the sense that they disagreed with his expectations. They "smelled" wrong . . . wrong enough for him to begin thinking about the unthinkable.

I think Campbell was familiar with who usually voted. Not necessarily as individuals, but as formats—names, addresses, styles of writing and paper selection. An experienced editor builds up a species of demographics from such clues. While it doesn't yield the kind of precise information Campbell was so much in need of, it has the feel of a homogenous population.

Ballot stuffing, which is the rigging method used, would represent an abrupt increase in the total of voters, and characteristics different from those of the reference demographics. Then it's a matter of analyzing who benefits, and using some method to tie "strange" ballots to specific authors. I don't know exactly what John did in that respect, but he was satisfied he'd identified the responsible individuals.

As to what he did about it: I don't know, any more than I know specifically who the culprits were. He would have terminated the AnLab immediately if he felt he had not been able to restore control over the bare equitability of the voting, no matter what it did to the official bonus system.

Some of the rigging could have been playful; confronted, the subject author could have proved to be one of those irrepressible ideationists who had deliberately chosen this method to demonstrate the fallibility of the AnLab method. In such a case, which could have been one of a small number of differently-motivated cases, Campbell might laugh, say "Point made!" and then change his expression, look up through his eyebrows and add: "Don't do it again."

I think something like that did happen in one case. But I don't think such a measure would have been appropriate in all the cases. I think it's possible—I have to say this, but I'm not happy with it—that having satisfied himself which the "wrong" ballots were, and the

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guilty authors being in some cases out of his personal reach, he *may* have simply tossed such ballots out of the voting thereafter. Long-term, of course, such a measure would ultimately make the AnLab meaningless, which is why I'm not happy about suggesting it . . . but he might have done it, because he had consummate faith in his intuition at all times, except for the exceptions, of course.

Another step would have been to blackball some writers out of *ASF* forever. It would have been characteristic of him to use all three approaches. He was a man of principle, not of egalitarian dicta.

All of the above are my statements pertinent to the validity of Dr. Bainbridge's study design. I have no quarrel with where his study rates me; I think that as far as what I did was ratable, I got a fair shake. I think the "core" *ASF* reader had good reasons to feel that a short story could not by definition deliver as much benefit as a longer story with extensively developed ratable ideas, and I was primarily a short story and novelette writer in *ASF*.

I thank Poul Anderson for his expression on my behalf. But my best novel of the period, *Who?*, was never submitted to *ASF*, another popular one appeared in *ASF* and other magazines only in pieces, a third followed approximately the same course, and a fourth was so bad that John and (unfortunately) *almost* everyone else bounced it for the dead clam it is. I think my perceived status with *ASF* readers, whatever it may be at this time, is somewhat higher than my rating, and I'm satisfied. I do think Poul makes an excellent point about the survey not equitably factoring-in pseudonyms. I had two; all three of us rated the same, but that might very well be a peculiarity of mine.

With regard to Jack Williamson's excellent essay on the value of critics, this letter demonstrates my addendum. I think critical thinking, applied with the best possible rigor, allows handling the past. Any one given thinker may reduce it to a package so rounded off that it is a total artifact,but if enough people tackle the same material, the discrepancies between packages may yield clues to truth, and save us from depending on nothing but oral tradition, which is amorphous per se.

I also think the existence of contemporary book reviews and author critiques yields to future observers a glimpse of what we think of each other and of our work, which may be quite different from how the uninformed future might look at the same examples.

Finally, I look forward to A.E. van Vogt stories in Analog. I remember that twenty years ago, in a professional newsletter, James Blish singled out another SF writer for recommended retirement. That writer recently received a major award for achievement in his special branch of speculative fiction. And of course if that species of critical declaration in some way indicates the eventual stature of the person making it, Tom Easton could not have chosen better company.

Sincerely,
Algis Budrys ■

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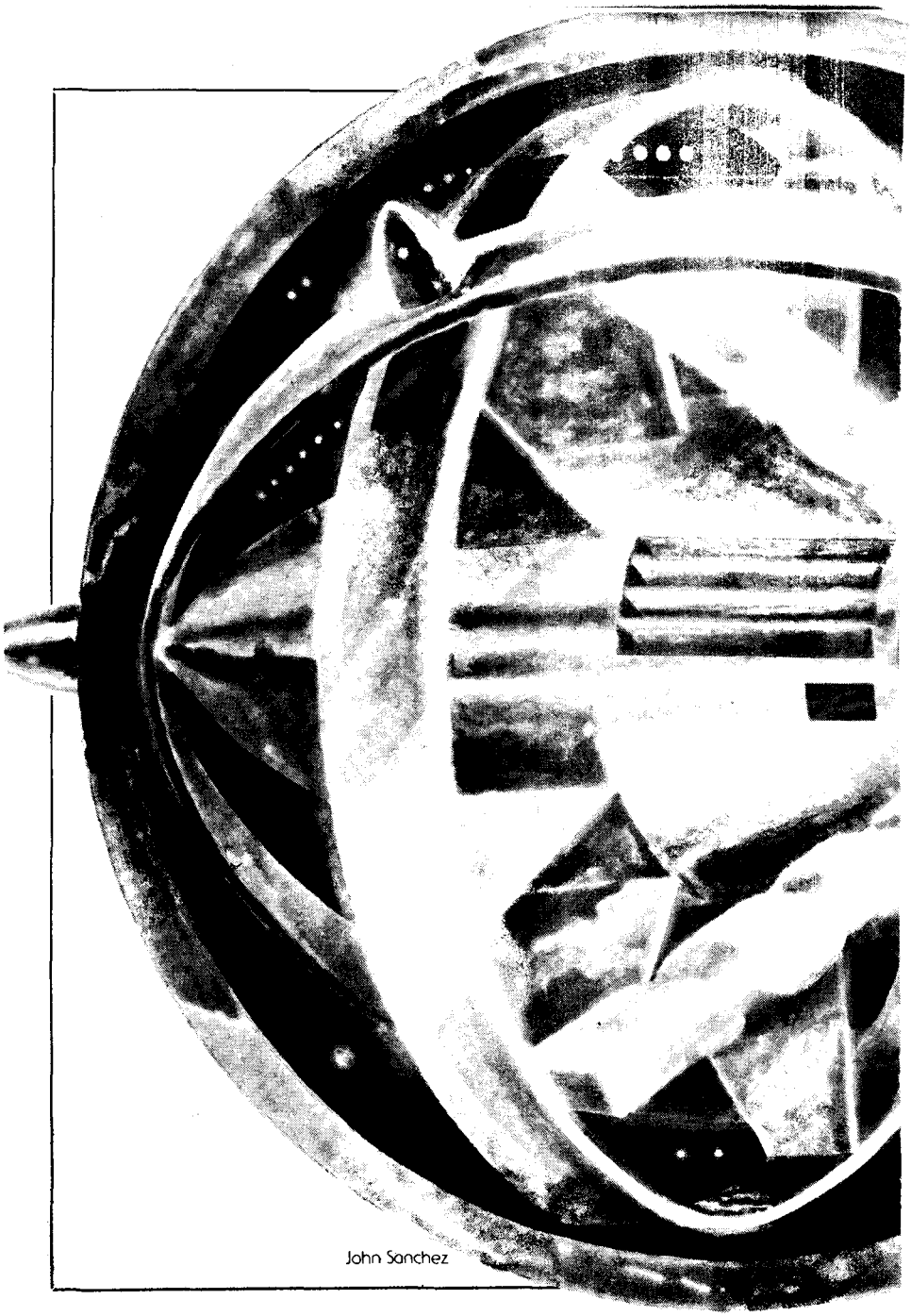

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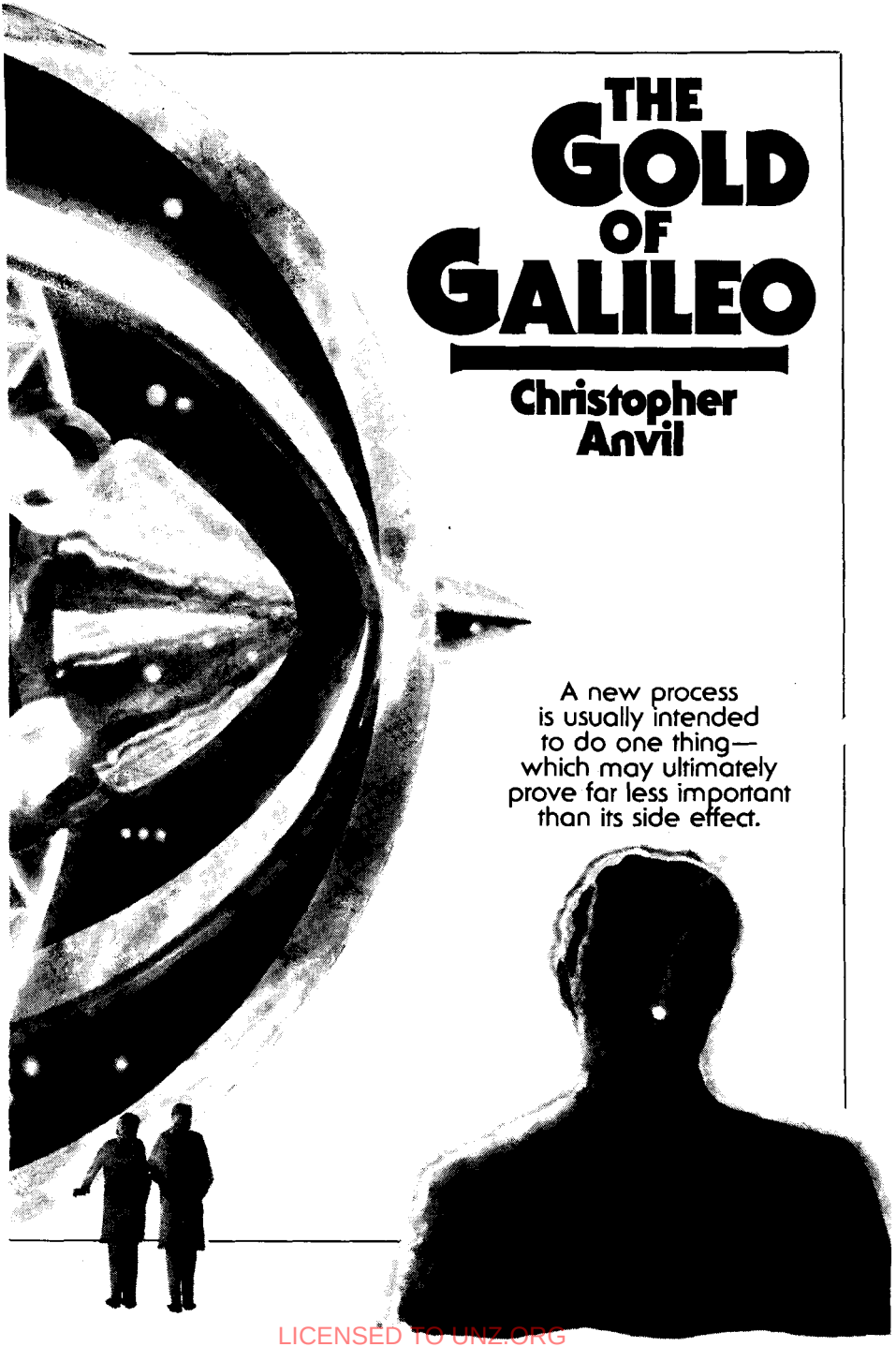

THE GOLD OF GALILEO

Christopher Anvil

A new process is usually intended to do one thing—which may ultimately prove far less important than its side effect.

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As he neared the curve at one hundred and ten miles per hour, Marius "Doc" Griswell kept his foot hard on the accelerator. His sleek sports coupe whipped up a cloud of moonlit snow as it went off the blacktop, to smash head-on into the stone wall.

The police, hastily called, found no skid marks.

James Cardan shielded his eyes from the wintry sun, slammed the car door, took the morning paper from the rack by the variety store entrance, and read the headline:

RUSSIAN REACTOR HIT
IN NEW MYSTERY BLAST.

Cardan paid for the paper, and, as he slid back behind the wheel, he glanced again at the front page. Separate from the main article was a familiar face, under the words: "Nuclear Scientist a Suicide?" Cardan, startled, skimmed the article:

" . . . famous atomic scientist, Marius 'Doc' Griswell . . . Director of Research for giant Hanwell Industries . . . died in an auto crash last night . . . considered a maverick for his theory that particle speed and position can be simultaneously determined . . . attempted to prove his theory with a huge 'cold fusion' reactor called the 'asterator' . . . keen analytical mind . . . much in demand lately to investigate the worldwide rash of nuclear accidents . . . 'We will miss him,' said Nobel prize winner, Dr. . . ."

Cardan, frowning, drove slowly across the tracks, past the big familiar sign "Research East," then parked in the freshly snow-plowed lot, and went inside. He unlocked a door lettered, "James Cardan, President," went through the outer office into his inner sanctum, tossed the paper on his desk, and hung his coat and hat in a small closet. He sat down, and, still frowning, took out a cigar.

Why should Doc Griswell commit suicide?

Cardan reread the article. The night had been clear, and Griswell knew the road; but there was no sign he had braked. Yet he had been in good health, respected, happily married, and highly paid by Hanwell Industries, whose president, Eli Kenzie, was Doc's personal friend.

Cardan groped for matches, lit his cigar, and sat back. Finally, he shook his head, looked at the headline, and carefully read the lead article. Two sentences stood out: "This explosion brings to six the unexplained nuclear blasts since the first at 3:26 p.m., September 29th, in the English Channel" . . . "as in the U.S. accident of November 9th, an explosion took place after the reactor had been shut down following an earlier alarm." A list of unexplained nuclear accidents followed:

1) 9/29 U.K., 3:26 p.m., submarine
2) 10/24 China, 10:23 p.m., missile
3) 11/9 U.S.A., 7:17 a.m., reactor
4) 11/17UU.S.A., 9:19 a.m., missile
5) 11/26 France, 3:09 p.m.,

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missile

6) 12/9 U.S.S.R., 6:02 p.m., reactor

Cardan at last folded the paper, and reluctantly turned to a problem he had put off in the hope that it might solve itself.

He had, during the start of what had looked like an impressive business expansion, hired people he expected to need later. The expansion had then evaporated, and now the need was to economize. Yet there was no one Cardan wanted to let go. And, as sure as day followed night, once he let them go, business would pick up, and he would have to scratch and scrabble to rehire them. But when would business pick up?

Scowling, Cardan unfolded the paper. Following the sports pages, the business headlines sprang up at him:

MARKET SLIDE CONTINUES!
ECONOMISTS ALARMED
AMEX CRASHES
ANOTHER GREAT DEPRESSION?
ADMINISTRATION URGES CALM

As Cardan knocked the ash off his cigar into the square glass ashtray on his desk, the phone rang. Grateful for the interruption, he picked it up, and a deep male voice said, "Jim?"

Cardan recognized Doc Griswell's boss at Hanwell Industries, and cleared his throat. "Eli."

"Have you heard about Doc?"

"I just read it in the paper."

"I got it last night. I came in early, to think things over."

"Why did he do it?"

"I—" Kenzie stopped, and began again. "You know, Doc thought a lot about that asterator project of his. I'm sorry, now, that . . ." His voice trailed off.

Cardan sat still, frowning.

Kenzie said, "I don't want to tie men up in that project. But I think, out of respect for Doc . . . I'm making a mess of this, Jim . . . Look, would you be willing to take on Doc's asterator? Don't rush it. Look into it, see what you think. After all, Doc was a genius. Maybe a fresh set of minds . . . The device hasn't produced yet, but, you know . . . fusion power . . . And if there's anything in it, we'd be glad to give you a participation. We might even sell the whole thing to you for the right price. What do you say?"

Cardan set his cigar carefully in the ashtray.

"How much," he said warily, "do you have in mind if we work on this for you?

Out in the company lot there were now two cars and a third pulling in. A slender, dark-haired man got out and his sharp features, as he looked at the second car, registered annoyance. He glanced up, and suddenly grinned.

At an upper window, a blond athletically-built man grinned back, with a slightly rueful expression. It might be childish—it *was* childish—but he took pleasure in getting here ahead of Mac. Since Cardan got here early, the whole place tended to, as if somehow it were a question of status to be early.

Behind the blond man, the intercom buzzed. Cardan's voice spoke inquir-

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ingly. "Don?"

Donovan said, "Right here."

"Mac in yet?"

"He's on the way up."

"We've got a job to talk over."

"Want me to tell him?"

"I'll let him know."

Cardan relit his cigar as Donovan and Maclane straightened from the newspaper looking grim.

"Is either of you," Cardan asked, "familiar with what Doc was working on?"

Donovan shook his head. "Only vaguely."

Maclane hesitated. "I've heard Doc's argument. But it involves mathematics I don't understand."

"How did he expect to get 'cold fusion'?"

"Doc argued that nuclei aren't statistical abstractions, but have definite structures. He said that to fuse two nuclei, there ought to be an optimum approach based on their actual structures. He said our nuclear fusion program only considers high-energy approaches. He claimed to have the mathematics to show that in certain cases a low-energy approach should work."

Donovan said, "Did he explain it?"

"Mostly by mathematics. The rough general picture I got was of electrical or magnetic fields, varied by computer according to nuclear location and attitude, rapidly bringing pairs of nuclei together. The advantage, if the method worked, was that there would be no plasma to wrestle with."

Cardan sat back, frowning. "Did you see any apparatus to *do* this?"

"No. Doc quit talking once he had the asterator."

Cardan described Kenzie's phone call. "Since we need the work, I didn't want to turn him down. But there's something Kenzie is very carefully not mentioning."

Maclane nodded. "We could be taking on a lot more than we bargained for. Doc wasn't easy to understand. To give you an idea, he was criticized for suggesting that particle speed and position could be simultaneously determined. You'd think if that *wasn't* what he meant, he'd have said so. But he acted sometimes as if he thought people deliberately misunderstood him, so why explain? It dawned on me finally that possibly that wasn't what he was arguing. He could have meant that the particles would naturally interact with the fields, to come together *somewhere* in the apparatus, with this 'optimum approach.' We wouldn't necessarily *know* their speed and position. But Doc never cleared up the point. There are bound to be other things he never explained about the asterator. It may be a nightmarish job to begin where Doc left off."

Donovan shrugged. "How can we lose? If the method works, we buy a participation. If not, remember, Kenzie's still paying us."

Cardan studied the glowing tip of his cigar. "Any chance of the asterator itself causing trouble?"

Maclane looked puzzled. "Trouble?"

"Trouble. Kenzie isn't *actually* doing this out of sentiment. If so, he'd just

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have some of his people keep on with the work. He implies it's sentiment, to provide an explanation that isn't subject to logic, or to questions of profit and loss. But in carrying out this sentimental gesture, just incidentally, the asterator moves around. Now *we've* got it."

Maclane blinked. "I hadn't thought of that."

"Any chance that it may be at some crucial point? When *we* run it, could it—say—turn into a little supernova?"

Maclane shook his head. "I don't think, from what Doc said—"

Donovan, scowling, said, "Remember that 'analysis of a sample' we did for hire a few years ago? Nobody told us they had reason to believe the sample contained a hallucinogen."

"I remember. They said their lab people were out with the flu."

Cardan picked up his cigar. "Let's go slow with this. There's some reason Doc slammed his car into that stone wall."

As the days passed and the weather worsened, Cardan took cheer from the fact that now he didn't have to let anyone go; but he lost an equivalent amount of peace of mind from the monstrosity rapidly taking form in the building around back known as "the hangar."

Shipped in sections, the asterator left everyone who looked at it speechless. To make things worse, there were the experts who came along from Hanwell Industries. Sporting mindless grins, they tended to jump at slight noises; they laughed heartily at the sickest jokes; they had to visibly put their minds in gear to answer a simple question. Donovan and Maclane, supervising the work, began to acquire a sleepless look.

Cardan himself, over a period of years, had been occasionally subject to what, for lack of a better name, he called nightmares. One chill night, at two a.m., he found himself sitting among tangled sheets in the quietly ticking blackness. Against the windows, there was a rattle of sleet. Cardan didn't move.

His occasional nightmares, if that was what they were, tended to occur with craftmanlike attention to detail. Grafted onto actual incidents in his life, they frequently seemed linked also to other nightmares, so that Cardan woke to the impression of living several interconnected lives at once. Sometimes, among the confusion of events, he found something of practical value, and he now carefully thought things over. If there was a lesson here, he wanted to find it.

Finally he got up, pulled the sheets straight and went back to bed. He knew that the psychologists would probably suggest he was suffering some unacknowledged strain. But, of course, that wasn't it.

Just before he fell asleep, he remembered something.

The asterator should be ready to test tomorrow.

The morning found Cardan pulling into the freshly snow-plowed company lot in a not very pleasant frame of mind. He had barely gotten through the drifts on his shortcut over the hills this morn-

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ing. So many cars were already here that the work might be proceeding without him.

Cardan went to the rear of the hangar and opened the door. Before him loomed the high, shadowy, faintly echoing interior. Against the gray light from the wide, paned doors on the far side, stood a towering frame like the gimbals of an enormous gyroscope. Within the frame was what looked like the broad side of a giant's discus, resting on its edge. Near the base, a knot of men dispersed, leaving Donovan and Maclane, dwarfed, looking up at the asterator. Then Donovan called out, his voice intense and faintly echoing: "Rotate both rings."

There was a hum, the disk moved. There swung into view against the light, the arching slender girders of an inner frame anchoring cables that stretched to the disk. Swirling out from the bulging central part of the disk were raised spiral arms reaching almost to the rim where each ended in an oblong, faintly outlined.

Donovan's voice was strained. "Stop!"

The hum died. The disk hung motionless.

Cardan looked up at it uneasily. He took time to light a cigar, then walked slowly toward Donovan and Maclane.

As he came closer, Cardan had a sense of the hulking weight of the apparatus which seemed to lean more and more toward him, tilting, ready to topple. The swirling spirals of the disk left him dizzy.

Cardan blew out a cloud of smoke, tore his gaze from the device, and was rewarded by a nervous strain that strengthened as he approached. He seemed to have walked a long distance when he reached Donovan and Maclane.

Donovan's voice sounded slightly unnatural. "What do you think of Doc's Folly?"

"I begin to see Kenzie's viewpoint."

Maclane said dryly, "We couldn't subcontract it to someone else, could we?"

"The thought has its attractions. But the idea was to keep *our* people busy."

Maclane nodded toward a nearby table. "Take a look at Doc's notes."

A mottled black-and-white bound notebook lay on the table. Cardan leafed slowly through pages of equations interspersed with lines of unreadable symbols. "Did Griswell keep his notes in Arabic?"

Donovan said, "According to Beasley, one of Doc's assistants, that's the Graham version of Pitman shorthand."

"How do we decipher this?"

"We've got an expert coming. That's the least of our worries."

"What else?"

"Beasley. And Allan, another of Doc's assistants."

"Still nervous?"

"Scared witless. But they won't say why."

Cardan looked up at the looming bulk. "Are the pivots on that thing strong enough?"

Donovan nodded. "It's all strongly made. But we don't feel comfortable in the same building with it."

Cardan cleared his throat. "You got

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it together faster than I expected.''

''Faster than *we* expected,'' said Maclane.

Donovan said, ''It practically fell together.''

Cardan glanced from Donovan to Maclane.

Donovan said, ''All we're doing now, though, is checking the mount.''

''Once you've checked it,'' said Cardan, ''let's stop there till we're sure what's in that notebook.''

''That's our idea.''

Maclane said, ''I'll show you one thing that's not in that notebook.'' He opened it past the last of the pages on which anything was written, and bent the pages back. The cut edge of another page was visible, sliced off close to the spine.

Cardan tilted the notebook, to see faint impressions indented on the blank page following.

''You might try a strong light crosswise on this page.''

Maclane nodded.

''Somehow,'' said Donovan, ''I begin to think we'll earn our keep on this job.''

Cardan, at his desk the following day, considered Doc's bound notebook which lay opened to a page of incomprehensible calculations. About two-thirds of the way down the page, there was a square root of negative one, circled, with a line drawn to a question mark and some unreadable symbols.

Across the desk, Maclane and Donovan were leafing through typed pages. ''Here we are,'' said Maclane. ''That comment near the question mark reads, 'Why this? What's the significance?' ''

''Doc didn't understand his own calculations?''

''Evidently not when he wrote that.''

Donovan said, ''We worked out what was on the missing page.''

''What?''

''A handwritten note:

''Eli—The times match. Marius.''

''That's all?''

''That's all.''

'' 'The times match'?''

''Right.''

''Whose writing?''

''Doc's.''

''No date?''

''Nothing.''

Cardan sat frowning. ''Supposedly, that note was to Doc's boss, Eli Kenzie.But suppose you wrote someone a note. What would you do?''

''If,'' said Maclane, ''the only paper handy was a notebook like Doc's?''

''Yes.''

''I'd tear out a sheet, then write the note.''

''Doc evidently wrote the note *first*, since it left an impression. *Afterward*, the note was cut out.''

Donovan said, ''You think Doc meant the note to be in the book? Then, before passing the book on to us, Kenzie cut out that page?''

''I'm wondering. Now, what are those 'times' Doc mentions? Could they be times mentioned in the notebook?''

''Very possibly,'' said Maclane, ''but they '*match*.' Match what?''

Cardan picked up the notebook, and examined the edge. ''Kenzie isn't stu-

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pid. And I don't suppose he thinks we're stupid."

Donovan nodded. "He must have known that as soon as we saw that cut page, we'd examine the next page. It follows he left it for us to find."

Cardan said, "Suppose Doc gave Kenzie information Kenzie wants to be able to deny knowledge of, but that he thinks we'll need."

"He leaves us enough to piece it together?"

Cardan nodded. "There's something here he's washing his hands of. What's in this notebook, now that your shorthand expert has it transcribed?"

"Aside from the math," said Maclane, "which we can follow only to a point, there are various comments, plus a record of asterator trials."

"And their *times*?"

"Yes. But what do the times match *with*?"

"Well, let's see what's in there."

Donovan handed over the typed trranscript.

Cardan leafed through it, reading the entries carefully: "October 30: Thirty-one second run, started at 10:30 this morning. Deuterons against the liner of chamber forty-two ended it. We do get cascade. But, again, there's no power. Yet there's helium-3 in the effluent. We must have fusion. But still, we haven't got it . . . November 9: Forty-eight seconds, starting around 10:17 a.m. The longest yet. But she shut down for deuterons in chamber forty-two. Again, no heat. Power goes *in*, not out. There's a sizeable power consumption in this thing. All we have to do is fix chamber forty-two, and we have workable fusion. *But where's the energy*?"

Cardan looked up. "Was it working?"

Donovan and Maclane shrugged helplessly.

Cardan read on, to the final entry: "December 9: Seventy-two seconds! Almost a minute and a quarter! Started a little after 10:00 a.m., and everything worked like a dream. Still this damned chamber forty-two wrecked us. We've done all we can by field control, positioning the frame, and tension on the shell. Best replace the whole track. Still no detectable output. Yet the energy has to go somewhere. Could the process induce some form of transparency in the apparatus? Why that imaginary factor? Is there a connection?' "

Cardan sat back. " 'Cascade'? What does that mean?"

Donovan said, "There are a great many paired 'tracks,' leading to 'coincidence chambers' near the rim. At any given instant, up each track comes a deuteron—a stripped nucleus of heavy hydrogen—moving in response to applied fields, operated under computer control. Two deuterons reach the chamber—"

"One deuteron from each track?"

"Right. By Doc's process, they are supposedly in the 'proper condition to fuse.' They come together—"

"What is the 'proper condition to fuse'?"

As Donovan hesitated, Maclane said, "There are quite a few things about this process we don't understand. Doc assumes that there *is* such an ideal con-

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dition, and he tries to attain it by a process that is partly clear and partly very obscure. There's a little note in there somewhere, 'Would they try to mate two cats by just throwing them at each other?' Doc's reasoning on control of the applied fields is another thing that's only partly clear to us. He evidently has his computer compare results in the different sets of tracks as well as successive performances in each pair, considered over time. The computer then adjusts the fields to 'optimize' performance. But the details aren't clear. He apparently set down just enough to remind himself of points he wanted to remember or to think about further. We can follow it only so far."

"At any rate, there is a deuteron from each track?"

"Right."

"And you say he controls the relative positions of the deuterons?"

"With applied fields, adjusted by feedback from each deuteron, whose fields affect the applied fields in ways which depend on the aspect and position in space of the deuterons."

"And the details you don't understand?"

Maclane shook his head. "Among other things, I can't follow his math. I'm not sure just how the feedback works. The details of the computer control are an enigma. I have only a hazy picture of how this device actually works."

"The deuteron," said Cardan, "has a proton and a neutron. Is the idea to get them lined up so they collide with the two neutrons closest, or slightly at an angle, or what?"

"Doc," said Maclane slowly, "represents this ideal condition for fusion by the Greek letter *omega*. He refers to it as 'the omega condition.' But to exactly picture it . . . It seems to me he is making further assumptions."

"He has a more detailed mental picture of the deuteron?"

"Or of the fields associated with it. Or, who knows?"

Donovan said, "I think that has to be it, Mac. The fields associated with it."

Cardan sat back. Then he shook his head.

Donovan said, "What is it?"

"There's something here I can't put my finger on. Something aside from what we're talking about."

Maclane said, "I have the same sensation. On top of everything else, there's something I can't pin down. I have the sensation of playing chess while I've got a bad case of flu. There are things I don't grasp."

Donovan said to Cardan, "What do we do? Test it? Or try to figure it out? We ought to be able to learn something from operating it."

"I'm still in the dark about this 'cascade' Doc mentions."

Maclane said, "To begin with, a deuteron test-stream is sent through each set of tracks in turn. If there's a malfunction, the asterator stops. If every set works, the asterator 'goes into cascade'—that is, all the tracks work, and build up to maximum capacities."

"Can you keep the asterator from going into cascade?"

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"We could test each set of tracks separately."

"Why don't you, tomorrow, test each set once. That would normally precede cascade, wouldn't it?"

"Yes," said Maclane.

"But don't let it go into cascade."

"Why not?"

Cardan didn't smile. "I've got a hunch."

Cardan that afternoon bought a small world globe and that evening installed himself with the globe, a long extension cord, a lamp, a card table, a metal ashtray, a folding chair, a pocket calculator, and an electric heater, in a small windowless shed built onto the hangar during an earlier project. The shed, covered with corrugated metal siding, had no telephone or electrical outlets. Free of buggable surfaces, the shed's rough new construction had provided reassurance at a time when they had wanted a place to talk openly without fear of electronic eavesdropping. The shed's metal siding was backed with thick insulation and, as the temperature dropped outside, Cardan was conscious only of the calculations he was making. At length, he looked up.

He was now almost certain. But almost, of course, wasn't good enough.

In late afternoon of the following day, after the asterator test, Maclane and Donovan came to Cardan's office.

Donovan said wearily. "No wonder Doc ran his car into that wall."

Cardan said, "You only *tested*?"

"Yes, and every track functioned. But there was no energy release. There has *got* to be an energy release!"

Maclane said exasperatedly, "This is really *cold* fusion. What the devil happens?"

At the door, there was a soft rap and Cardan called, "Come in."

His secretary stepped into the office, looking pale and shaken. "You asked me specially to listen to the news."

"Go ahead."

"They reported a scare at the Scoville nuclear power plant."

"A scare?"

"They're shutting down the reactor."

"Did the report say when it happened?"

"A little after three, at Scoville."

"Any details?"

"Not in the news."

Cardan nodded, and sat back. "Thanks."

She swallowed, and went out.

"A friend of mine," said Donovan uneasily, "works at Scoville." He frowned. "A little after three?"

Maclane nodded. "It happened just an hour before we tried the asterator."

"Scoville," said Donovan, "is *in the next time zone*. It happened *when* we tried the asterator."

Cardan exhaled carefully. "As Doc said, 'The times match.' You didn't move the asterator after the test?"

"No."

"We'll have to try it again. Whatever you do, don't let it go into cascade."

Cardan, a cigar jutting from the corner of his mouth, stood behind Maclane, who sat at a small panel, and

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methodically tapped a yellow button labeled "TEST." On a little oblong screen, the red digits "083" lit up, followed by "084," then "085."

At a small table to the side, Donovan was talking on the phone to his friend at the Scoville plant. Suddenly Donovan gestured. "Scoville! More trouble!"

Maclane sat staring at the glowing numerals: 085. Cardan tapped him on the shoulder. Maclane wrote briefly in his notebook, shut off the asterator, and came to his feet. Cardan led the way to the windowless shed, unsnapped the padlock, and shut the door behind them. In the darkness, they could hear the whir of the heater fan. Cardan felt along the extension cord and snapped the light switch. The papers were lying on the card table as he had left them. He turned two of them face up, for Donovan and Maclane to read:

Asterator Runs

Date	Length of Run	Apprx. Time Run Started
9/29	30 sec.	10:25 a.m.
10/11	22 sec.	10:22 a.m.
10/24	41 sec.	10:24 a.m.
10/27	24 sec.	10:14 a.m.
10/30	31 sec.	10:30 a.m.
11/9	48 sec.	10:17 a.m.
11/17	46 sec.	10:19 a.m.
11/26	54 sec.	10:08 a.m.
12/2	29 sec.	10:11 a.m.
12/9	76 sec.	10:01 a.m.

Nuclear Accidents

Date	Place	Local Time	Corresponding Time at Asterator
9/29	Britain	3:26 p.m.	10:26 a.m.
10/24	China	10:24 p.m.	10:24 a.m.
11/9	U. S.	7:17 a.m.	10:17 a.m.
11/17	U. S.	9:19 a.m.	10:19 a.m.
11/26	France	3:09 p.m.	10:09 a.m.
12/9	Russia	6:02 p.m.	10:02 a.m.

Maclane said, "No wonder Doc killed himself!"

"It's obvious," said Cardan, "once we get over the idea it's impossible. "Eight of the twelve times that asterator has been run, there's been a nuclear accident somewhere. And, since this string of disasters started, there have been no nuclear accidents reported except when the asterator has been run."

Donovan and Maclane stared at the papers. Then Donovan turned, to look at Cardan. "But, how?" said Donovan.

Cardan shook his head. "I can't imagine. But if every time I snap on a flashlight the object it's aimed at blows up, then I am going to be very careful with that flashlight."

Maclane shook his head. "This is totally impossible."

"It happened," said Cardan. He raised his cigar, discovered he was holding a dead stub, and tossed it into the ashtray. "If something happens that is impossble, we've got only two explanations that I can see. First, we're

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● Science cannot solve the ultimate mystery of nature. And that is because, in the last analysis, we ourselves are part of nature and therefore part of the mystery we are trying to solve.

MAX PLANCK

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wrong about what's impossible. Second, what happened is different from what we thought."

Donovan straightened. "Mac—"

Maclane glanced at him.

Donovan said, "That asterator has its fields controlled by a computer, the intent being to 'optimize the ease of fusion.' There's a whole sequence of operations right there that we don't understand, that Doc's notes don't explain, and that his assistants couldn't clear up for us."

Maclane's eyes narrowed. "That's true."

Cardan frowned, felt his pockets, located a fresh cigar, and absently stripped off the wrapper. "The computer is intended to adjust the fields to 'optimize the ease of fusion?' Not to 'achieve the necessary conditions' for fusion? *Optimize* the ease of fusion?"

Maclane nodded. "There's a difference in viewpoint involved. I think Doc expected first to get a partial success, and the computer was then to vary conditions, trying for a better result."

"By stages, he'd arrive at perfection?"

"As close to it as possible. And each set of tracks, having slightly different conditions to start with, would supposedly have a slight difference in the number of successful fusions of deuterons. The computer apparently compares the results, draws conclusions from them, varies the conditions further, and then brings all the tracks to the optimal condition—to equal the best results achieved by the best set of tracks. If some one set can't closely equal the results of the others, something is wrong, and the asterator shuts down."

"But," said Cardan, tossing the crumpled cigar wrapper into the ashtray, "when does the computer stop trying to optimize conditions? When there is one hundred percent fusion of deuterons?"

"Not necessarily. There may be a better approach with the same result, say a more efficient use of the energy to generate the fields. So the computer keeps varying conditions."

"Supposedly," said Donovan, "this will stop when every possible change produces a falling off in efficiency."

Cardan, scowling, felt in his pockets for matches. "How does the computer judge the proportion of deuteron pairs that fuse?"

Maclane glanced at Donovan who shrugged helplessly. Maclane looked back at Cardan. "We don't know. Doc knew, of course. But he had a lot of leeway at Hanwell. He just gave instructions, and he didn't always explain them. These so-called experts sent along with the asterator couldn't tell us. In time, we should be able to work it out. But we can't do much if, every time we turn it on, there's an atomic scare."

Cardan struck a match, and puffed his cigar alight. He shook out the match, and said, "There's nothing like strict logic for getting from the sublime to the ridiculous, and a computer is strictly logical. All right, suppose we just imagine that we've turned on the asterator for the first time. A proportion of deuterons fuse. What happens?"

Maclane said, "The computer tries

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field alterations, and keeps bringing the lowest tracks up to the levels of the more successful tracks. That, at least, is our understanding of it."

"So, now, finally one set of tracks achieves one hundred percent successful fusion. Then what?"

"The computer brings all the others to the same state, and varies conditions further to see if some approach uses less energy. It then brings every track to the same condition, so far as possible."

Cardan frowned. "Mac, *where* will fusion take place?"

"Somewhere in the coincidence chamber."

"At different places? Or—"

Donovan gave a low exclamation. "We've been assuming fusion at random locations within the chamber, with the deuterons in slightly varying relative positions. But what if there are quantum effects that limit the possibilities? Or if there is one *optimal* location and attitude, and finally all the deuterons fuse at that one location and in that one attitude?"

"And," said Maclane, "each pair of fusing deuterons in any given chamber expels its neutron in the same direction, and with the same energy, as every other deuteron pair in the chamber?"

"Yes," said Donovan. "Mac, that would give us a ray of neutrons!"

"Wait, now. In cascade, the numbers of fusing deuterons will be enormous!"

Cardan said, "Meaning?"

"Meaning," said Maclane, "that if this *does* happen, we could end up with—" He paused, his eyes widened, and he glanced at Donovan.

Donovan let his breath out in a hiss. "It could produce a ray of closely packed neutrons possibly turned to identical attitudes with respect to one another, identically spaced, with God alone knows what possible linking of forces, or, perhaps, breakdown into smaller particles."

Cardan, for a brief instant, saw a thin compact ray hurtling through space, straight toward a complex nucleus. The ray, stretching far back, was, along its length, packed, dense, and massive. Its influence reached ahead of it, and. . . . Abruptly, the vivid mental picture vanished, and Cardan said, "When it approaches an atomic nucleus, what will happen?"

Donovan shook his head. "We've got no basis for comparison."

Maclane said, "That's the problem. It's almost like a long thin sliver of neutron star."

"Maybe worse," said Donovan. "Along its axis, this ray could involve a lineup of neutrons a hundred or a thousand times in length the diameter of a neutron star. There's no way to predict the forces involved."

"Then," said Cardan, "for a rough approximation, take something worse than a neutron star."

Maclane began to object, but Donovan, frowning, said, "The only thing I can think of would be a black hole."

Maclane shook his head. "That would take us beyond speculation into the realm of speculation squared. We're trying to understand one unknown by comparison with another unknown. Then we have to apply a correction to make

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up for the lack of the main characteristic of a black hole—an enormous gravitational field. It won't work."

Cardan, frowning, recalled all that he had heard of black holes, shook his head, and was about to agree with Maclane that this was too strong a comparison. But Donovan was nodding, and said, "I think that's it. The comparison doesn't have to give us the guaranteed answer. What we need here are ideas, and this analogy suggests one. Near a black hole, space-time is warped, due to the enormous mass involved. To an external observer, an object falling into a black hole will seem to fall *for an infinity of time*. Now, I'm no expert on black holes, but there is one difference between stable nuclei—which in effect must be transparent to the ray emitted by the asterator, or it could never affect nuclear installations at such a distance—and unstable nuclei, which are decomposed by it."

Maclane said, "I can imagine a ray like this penetrating a stable nucleus. After all, a sufficiently energetic neutron may strike a nucleus, and pass through unaffected. If the neutron's wavelength is short enough, it has a measurable chance to pass between the nucleons—the protons and neutrons that make up the nucleus itself. But, why should this ray decompose an *unstable* nucleus? Where's the difference, as far as penetration by the ray is concerned?"

Cardan glanced at Donovan, and asked, "The asterator ray would pass through the stable nucleus like a rod pushed through a bunch of grapes?"

"Yes."

Maclane said, "Why wouldn't it do the same with an unstable nucleus?"

"Because," said Donovan, "the instability—"

"Some of these 'unstable' nuclei have half-lives of over a billion years."

Donovan nodded. "But the instability means that, given sufficient time, the nucleus will spontaneously decompose. All that's necessary is sufficient time. No outside energy needs to be supplied. The unstable nucleus will decompose by itself, in time. And," added Donovan, "we are in the position of external observers, watching as this dense ray approaches the successive nuclei. It must penetrate normal matter with no noticeable effect. From what we observe, it also must decompose radioactive nuclei. How? In front of this long dense ray, it's natural to expect a terrific field-distortion, roughly the kind of thing we'd expect with a very long, powerful magnet. But what kind of field-distortion? Is it a linking of strong nuclear forces? We have no way to know. But, take the black hole, just for comparison. To the external observer, there are time-related effects. An infinity of time seems to pass before an external object falls out of sight. Suppose we have a similar thing. The ray approaches a stable nucleus. The intense distortion at the head of the ray impinges on the nucleus. The nucleus experiences the equivalent, for it, of the passage of an *infinity of time*. What does the observer see?"

"Nothing," said Maclane, frowning..

"Right. Which is exactly what we would expect to see in an infinity of

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time, since the stable nucleus is outwardly unaffected by time. But the *un*stable nucleus, exposed to what, for it, is the equivalent of the passage of infinite time? Even if the half-life of that kind of atom is enormous, what of it? In infinite time, *it will decompose*. All radioactive nuclei in the path of the ray will decompose."

Maclane, frowning, said, "Let's get back to this field-distortion at the head of the ray. You don't say it *is* time?"

"Equivalent, for the nucleus, as the ray approaches, to the passage of infinite time."

"How," said Maclane, and then he paused. "The nucleus of an unstable atom supposedly is unstable because its components—protons and neutrons—are not in the right proportions to stay permanently linked together. There is a configuration—a relative position within the nucleus—in which the protons and neutrons no longer hold each other together, and sooner or later they come into that configuration. Then time, for the nucleus, is *the opportunity to take different configurations*. This 'field distortion,' approaching and then passing into and through the nucleus, must have the effect on the binding forces within the nucleus of successive changes in the configuration of the nucleus. Those changes in binding force that would eventually have come about due to changes in configuration, are briefly brought about by the field-distortion. And the nucleus comes unbound."

Donovan glanced at Cardan. "There's a conceivable mechanism for it."

Cardan discovered that he was holding a dead cigar and a burnt match. He tossed the match into the ashtray and said, "So, in its effects overall this asterator is like a kind of enormous lawn sprinkler, spraying these rays in random directions. Now, let's see. Each coincidence chamber emits its own ray?"

Maclane and Donovan nodded.

"But," said Cardan, "if by chance some one ray strikes a nuclear installation, can this *one* ray affect enough nuclei to detonate, say, a reactor *that has already been shut down?*"

Maclane said, "There's another point about the ray that we have to consider. The computer optimizes the ease of fusion."

Donovan, frowning, said, "True. But we've already considered the point. I think the Chief's reservation is right. *One* ray couldn't do it."

Cardan winced at the nickname, "the Chief." Where Marius Griswell had been stuck with being called "Doc," Cardan found himself repeatedly objecting that he didn't run a fire company, or lead an Indian tribe. Still, it could be worse. One hot-tempered acquaintance had discovered he was known as "the Dragon." Cardan glanced at Maclane, who was shaking his head.

"Wait a minute, Don. If we accept this effect, then the ray directly in line with them is bound to affect the fusing deuterons."

"Yes, I suppose. Still, Mac, the ray is moving *toward* the target nucleus. It's moving away from the deuterons. So—"

"I didn't say the effect would be the same. I said there'd be an effect."

"Yes. That seems reasonable."

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"This effect may for some reason finally lessen the ease of fusion noticeably. Then what?"

Donovan nodded. "Yes, I see. Well, the computer will shift its fields and after a slight delay the deuterons will fuse in a different part of the coincidence chamber. It will start a new ray. That's *it*, Mac! In cascade, the coincidence chamber will be radiating detonation-rays the way a machine-gun sprays bullets. It will be bound to hit something if it's left on long enough."

"And," said Maclane, "when some one ray does hit a series of radioactive nuclei, I wonder—how will the computer interpret the result?"

"I'd think the break up of the radioactive nucleus might well exert forces at an angle to the axis of the ray. That could have the effect of destroying the far end of the ray. Repeated often enough with other radioactive atoms, that would limit the length of the ray, and supposedly limit the effect of the ray on the fusing deuterons. That compared to rays that hit no such target would be interpreted by the computer as optimization."

"Then," said Maclane, "that would do it! The computer would try to optimize the conditions for fusion in all the other chambers by shifting the fields to make the conditions identical, as if using the position and attitude of the nuclei in the optimal chamber as a model."

Cardan said, "And this will?"

"Aim every last ray from the asterator in the direction of the nuclear target. And, if the rays don't all hit, the computer will keep making minor adjustments to optimize the conditions. Very quickly it should have every ray focused on the target."

"Then," said Cardan, "with no intent on Doc's part to do this, the asterator will, first seek a nuclear target and then, second saturate the target with nuclear detonation rays."

"Yes. In effect."

In the bare room, the sound of the electric heater fan seemed loud, as they thought this over.

Cardan nodded slowly. "This at least gives us a mental picture. But right or wrong, it is still all theory. And however it turns out there's an actual application that may catch up with us anytime."

"What's that?"

"However this works, it *does* work. And it's no fusion reactor."

"No, it's not practical. Unless—"

"Not practical as a fusion reactor. But it's potentially one of the most brutally practical weapons ever made."

Maclane glanced at the two sheets of paper.

Cardan said, "All that's needed is an aiming mechanism and whoever has an asterator can choose whose nuclear installation gets blown up. Even now it's bad enough. If we merely turn on the asterator and keep putting it in cascade we can almost count on as many nuclear disasters between now and six o'clock tonight as the world has seen till today. In a total of two hundred and eighty seconds, Doc set off six nuclear accidents. And he wasn't trying. What would half-a-dozen more nuclear disasters do? How many A-bombs and

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warheads are there out there, waiting to be set off? How do you stop a ray that can penetrate matter?"

Donovan said, "And Kenzie knew it!"

Cardan raised his cigar, found it was out, considered relighting it, and waited thoughtfully while Donovan and Maclane said what they thought of Eli Kenzie. When the worst had passed, Cardan said, "Kenzie probably got Doc's note when it was too late to save Doc. He was stuck with the asterator, with no one he trusted to work on it. He didn't dare tell us why he was hiring us. But I never heard a more fake explanation. And he must have known I'd know it was fake."

"You're saying he warned us?"

"And offered to sell us the device. My guess is, he's willing to pay for some kind of decent outcome to this mess. I think we should take him up on it."

"What? Buy the asterator?"

"A part interest. Given Doc's reputation, and the obviousness of those lists, we can't tell who may know about this. We're even responsible ourselves for two near-disasters. We *can't* quit. We may as well make something out of it."

Maclane stared. "You're not thinking of a commercial application?"

"What else?" said Cardan.

Eli Kenzie glanced around the shed, folded his overcoat, seated himself at the card table, and moved his briefcase closer. He took out a monogrammed handkerchief and wiped his forehead, his upper lip, and the back of his neck. He glanced at Cardan. "Mind if I adjust the eavesdropping environment?"

"Go ahead."

Kenzie opened his briefcase, took out three flat boxes, put one on the table, one on the floor, and one on the seat of an empty chair. He flipped switches, and each box gave out its own mixture of conversation, offbeat music, and apparently random sound effects. He produced two lightweight headsets, connected by a cord, and tossed one to Cardan. Cardan slid it on, and Kenzie's voice spoke in his ears: "Let anyone try to decipher this garble. You said on the phone you want a part of the asterator?"

Cardan adjusted the mouthpiece. "Right."

"You know what it does?"

"We know one of its little effects."

"We'll sell you the whole thing, cheap. How's that?"

"We'd like fifty percent even better."

"You want help financing what you've got in mind?"

"Right."

"What arrangements?"

"We turn it into a commercially practical setup with your backing. You then get fifty percent of the profits."

"Where's the profit in this sackful of cobras?"

"Do you agree?"

"Sure. We'll sell you half, keep half for ourselves, and take fifty percent of the profits as the payment. But before we put any more money in this thing you have to convince us it makes sense."

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Cardan nodded, signed two prepared copies of a briefly worded agreement and slid them across to Kenzie who read them carefully, signed, folded one copy into his pocket and sat back.

"You understand, we can't hope to just develop this as a nuclear-missile defense. Once word gets out, we've got an instantaneous international crisis. There has to be an answer for that, too."

Cardan slid a thick sheaf of papers across the table, and said dryly, "Our plans are fairly wide-ranging."

Kenzie examined the papers. His eyes widened. He cast a sharp glance at Cardan, and slowly nodded.

Cardan, as the weather grew bleaker, continued to buy his accustomed newspaper each morning and found the news no worse than usual until that time of the year when road crews begin to wonder where to put the next snowfall. That morning Cardan climbed over the dirty gray snowbank at the curb, crunched across the salted ice on the sidewalk and found himself looking at a headline that read:

NEW ATOM BLAST!
ANOTHER ACCIDENT!
NUKE RESPITE ENDS!

In his office, Cardan questioned Donovan and Maclane, who stared at the map in the paper, and shook their heads. "There is no way we could be responsible this time for that blast."

"Then someone else has one. Whether they realize what it is or not."

The next morning's headlines read:

A-BLASTS IN RUSSIA
AND CHINA! PANIC
SWEEPS THE WORLD!

Cardan read this in a Washington, D. C., restaurant at breakfast with Kenzie. At ten they were talking to a fear-paralyzed Secretary of Commerce. By ten forty-five they were describing the situation to the President, who listened wide-eyed. "Why didn't you tell me sooner?"

Kenzie said, "We didn't want to hand you this basket of snakes until we felt sure we had an answer."

"What is it?"

Cardan handed over a sheaf of neatly typed papers and diagrams clipped together at the top. He and Kenzie waited. The quiet in the room was broken only by the crackle of turning paper. Then the President took a deep breath. "We'll try it."

In the following months Cardan had little time to do more with the newspaper than glance at the headlines. Certain of these stood out:

U.S. CALLS FOR
ATOM PARLEY!

PRESIDENT USES HOT LINE,
URGES NUKE CONFERENCE

U.S. REVEALS NUKE DEFENCE!
BLOWS UP MISSLES IN FLIGHT!

RUSSIA, CHINA, ALL NUKE
POWERS AGREE TO CONFER

ATOM CONFEREES AGREE!
WEAPON LIMITS STATED!

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ATOM WEAPONS BEING
PUT IN ORBIT AROUND SUN
BY U.S. COMPANY

It was about the time that last headline appeared that Cardan found himself on a program known as "Face the Press," grimly answering questions nicely slanted to make him squirm.

Mr. Skinner: Now, you are removing these warheads for profit? Do you actually think you have a right to make money from the potential destruction of the human race?

Mr. Cardan: We're on the edge of nuclear disaster. Putting all these excess warheads far from Earth costs money. Naturally, we expect to get paid for the job.

Mr. Kauldron: Are you aware that the Soviet Bloc possesses a vast military superiority to the United States and our allies in conventional weapons? Suppose all this unilateral nuclear disarmament strikes the Soviet Bloc as an invitation to conventional attack?

Mr. Cardan: If—

Mr. Kauldron: And the next part of my question is, are you the one who's responsible for all the deaths in nuclear accidents?

Mr. Cardan: Who said it's unilateral disarmament? There have even been reports of—

Mr. Kauldron: How do you defend against an attack by overwhelming forces using conventional weapons, in which they have a huge advantage?

Mr. Cardan: If it comes to that you plaster them with rocks from space.

Moderator Cooke: Ah, I believe, Mr. Cardan, you just said that there 'even were reports'—reports of what?

Mr. Cardan: 'Nukeleg blackmail.'

Moderator Cooke: What . . .

Mr. Cardan: A large nuclear power makes a secret trade with a developing resource-rich nation, A-bombs for raw materials, at a time when the small nation hasn't yet heard of asterators.

Mr. Boyle: The big nuclear power smuggles the warheads in?

Mr. Cardan: Yes.

Mr. Boyle: Then I see the nukeleg part. Where does the blackmail—?

Mr. Cardan: After the warhead has been delivered, what do you suppose happens next?

Mr. Boyle: I . . . Ah—

Mr. Cardan: Suppose a ray from an asterator should happen to hit that warhead?

Moderator Cooke: The seller threatens to blow up the warhead he just sold?

Mr. Cardan: He explains that his asterator might, just accidentally, sweep a ray across that warhead. To avoid that, he will have to attach special expensive devices to the asterator. There'll have to be more payment—more raw material.

Moderator Cooke: Incredible!

Mr. Kauldron: Mr. Cardan, you said we could drop rocks if we're conventionally attacked.

Mr. Cardan: Small captive asteroids, in orbits we contol. In effect, man-made meteors. The result would be as bad as getting hit with a hydrogen bomb.

Mr. Kauldron: What's to prevent any opponent from doing the same to us?

Mr. Cardan: Right now, there are more of us up there.

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Mr. Boyle: If I'm not mistaken, you're using the Hi-Lift Super-Booster and the Hi-Sky Modular Transport System, to move these warheads. These are Hanwell Industries projects that were rejected by the government for use in the space program. Is that right?

Mr. Cardan: Yes.

Mr. Boyle: Why were they rejected?

Mr. Cardan: Too expensive.

Mr. Boyle: Then—correct me if I'm wrong—in this series of nuclear disasters, Hanwell Industries has invented a reason for the government to buy their system.

Mr. Cardan: The government hasn't bought them. We use them to move the warheads. The government just pays a fee for warhead removal.

Mr. Boyle: Why do you use this government-rejected system?

Mr. Cardan: It's big enough to do the job.

Mr. Boyle: You have to admit, it looks like some sort of scheme to get the Hanwell Industries systems in commercial use.

Mr. Cardan: Well, maybe. But, gin and water look alike. If you see a man drink a pint of water, does that make him a drunk?

Mr. Kauldron: Some time ago I asked if you should be blamed for the death of people killed in nuclear accidents. You haven't answered the question.

Mr. Cardan: Doc Griswell apparently thought he was responsible, but that involves a question you might have trouble answering.

Mr. Kauldron: What question?

Mr. Cardan: If you're driving on a curving mountain road in winter, and sunlight reflects from your windshield momentarily blinding a skier going down a tricky slope and the skier gets killed, are you responsible?

Mr. Kauldron: I—Ah—

Mr. Cardan: The asterator beam was even less foreseeable.

Mr. Skinner: Is the beam dissipated or dispersed after a certain distance or length of time?

Mr. Cardan: We've assumed that it may be. We've found nothing to prove it yet.

Moderator Cooke: Mr. Cardan, your Planetary Freight Corporation is a business, not a government-subsidized agency. What do you sell?

Mr. Cardan: Nuclear transport and storage. There is a safe-delivery charge to put the warheads in storage, a small rental fee while in storage, and a charge to withdraw warheads from storage, if anyone ever wants to do that.

Mr. Boyle: Where are the storage sites?

Mr. Cardan: On the far side of the Earth's orbit beyond the sun, keeping pace with the Earth.

Mr. Boyle: Why there?

Mr. Cardan: The asterator can't be accurately aimed at a target no one can see. And we find that the beam can't penetrate a mass of radioactive nuclei; it's apparently dissipated when the nuclei decompose. The sun contains an enormous mass of radioactive nuclei, and therefore should stop any asterator from hitting the warheads.

Mr. Kauldron: And if you blow up the sun? That's an improvement?

Mr. Cardan: The asterator ray is puny compared to the mass of the sun. It

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should have less effect than tossing a kitchen match into a roaring bonfire.

Mr. Boyle: Until asterators are put in space, away from the Earth the warheads are safe?

Mr. Cardan: That's our belief.

Mr. Kauldron: Why should a communist country pay a capitalist company to freight their warheads into space? They could make equally effective equipment themselves, couldn't they?

Mr. Cardan: When a crocodile has you in its teeth, do you take time to argue ideology?

Mr. Skinner: How do we protect our nuclear power plants? We can't put them in orbit.

Mr. Cardan: To protect them, we've developed the Dust Shield and the Whirlpool.

Mr. Skinner: What are—

Mr. Cardan: The Dust Shield is a set of shells surrounding the reactor. Blasts of gas through the shells circulate a dense, mildly radioactive dust. An asterator ray aimed at the reactor is absorbed by, and decomposes, the dust in line with it. More dust is constantly swept around, so the ray can't get through. The Whirlpool is based on the same idea but uses a liquid.

Mr. Skinner: You make the asterator, which causes the need for these devices. Then you sell the devices. You're really working both sides of the street, aren't you?

Mr. Cardan: If you'll think this over, I think you'll agree that there are worse things to do than protect the reactors and put the bombs on the far side of the sun.

Moderator Cooke: Is there any other development related to the asterator?

Mr. Cardan: The Asterator Drive which is a spaceship drive.

Moderator Cooke: How does that work?

Mr. Cardan: Picture a pencil made of lithium deuteride around a core of a radioactive material. When the asterator beam strikes the core, the radioactive material disintegrates causing the fusion of the lithium deuteride with a tremendous release of energy which can be used to drive a spaceship.

Mr. Kauldron: Doesn't that mean you're now polluting space itself with radioactive waste?

Mr. Cardan: The details are secret, but the current model also decomposes the radioactive waste.

Mr. Skinner: But. . . . That drive is controlled hydrogen fusion! Isn't it?

Mr. Cardan: Yes.

Mr. Boyle: Is this apparatus subject to being blown up by the asterator?

Mr. Cardan: Certain parts could be, but they are heavily shielded.

Mr. Kauldron: So, why can't a shield be used to protect atomic weapons?

Mr. Cardan: It can be. But there's a continuous expense in running the shield. Then to use a warhead the shield has to be taken out. To deliver the warhead you need a delivery shield. None of this makes for quick and easy delivery of nuclear warheads. Incidentally, if the shield fails, the warheads may get blown up while you've still got them.

Moderator Cooke: Gentlemen, our time—

Mr. Kauldron: I have just one short question. First—

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Moderator Cooke: —is up. Thank you, *Mr. Cardan*, for being with us on 'Face the Press.'

It was some months later that Cardan sat considering the handsome painting lying on his desk. Neat grids of warheads moved through space with a watch station in view in the background. Cardan didn't care to think how much nervous sweat had gone into this job. But most of the rough part, happily, was finished.

Donovan, looking at the painting, shook his head. "I'd never have believed any country would volunteer for nuclear disarmament, much less all of them."

Maclane said, "I wonder what the moral of this experience might be? 'Every sword has two hilts'?"

" 'A thousand bombs in the distance.' " suggested Donovan, " 'are better than one underfoot.' "

Cardan said, smiling, "You're both philosophers. It's also possible to find a research and business moral in this."

"What's that?"

"There are," said Cardan, "two well-known kinds of gold mines. The first yields a heavy yellow metal. The second is the mine Galileo opened up, and that Newton, Edison, Goddard, and Doc Griswell—each in his own way—worked in. There are a lot of differences between those two mines, but there's one little thing they have in common."

"Which is?"

"Neither mine has to yield 100% solid nuggets to be worth working. A fraction of a percent is enough. So however unpromising an ore may look, if what you want is there at all, things may still work out: *The secret of the work is in the refining.*" ■

In Times to Come

Man is just now beginning to open up the frontiers of space, but last year Michael McCollum, in his popular novelette "Beer Run," opened up something obviously (!) much bigger: an ongoing war between two vast empires which ranged not over space but over paratime, an intricate network of not-quite-parallel universes, with our "time-line" caught in the middle. McCollum's hero in spite of himself, Duncan McElroy, was snatched into that conflict, and many readers expressed an interest in what happened afterward. Next month you'll find out in our lead novella, nicely packed with both action and provocative ideas. I'll leave the details to the story; suffice it to say, for now, that that which is obvious is not always right—and McCollum likes to seek out the unobvious implications of ideas. The story is aptly titled "A Greater Infinity," and John Schoenherr is back with the cover.

L. Sprague de Camp has long been well known to readers of Astounding (and its companion magazine of fantasy, *Unknown*) and Analog, not only for his stories but for such thought-provoking fact articles as "Language for Time Travelers." It is in the latter capacity that he joins our Fiftieth Anniversary celebration next month, with some thoughts on "Man's Biological Future." Are we still evolving—and if so, in what direction?

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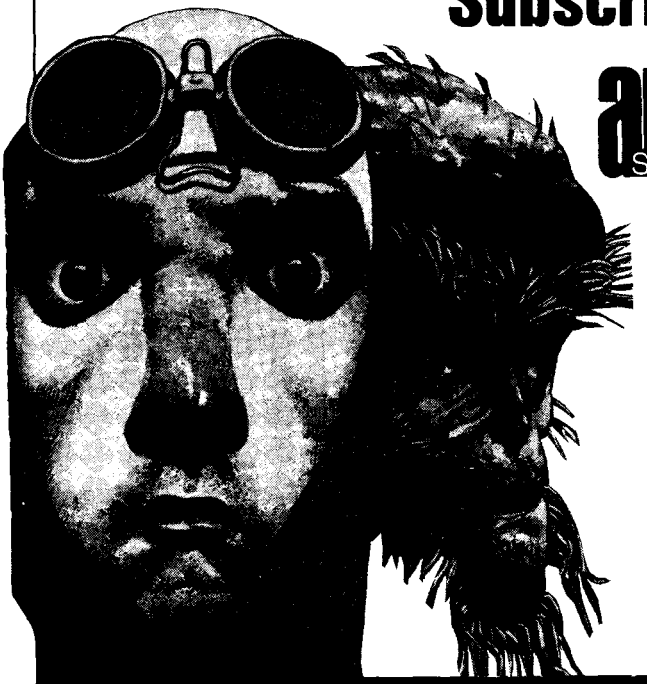

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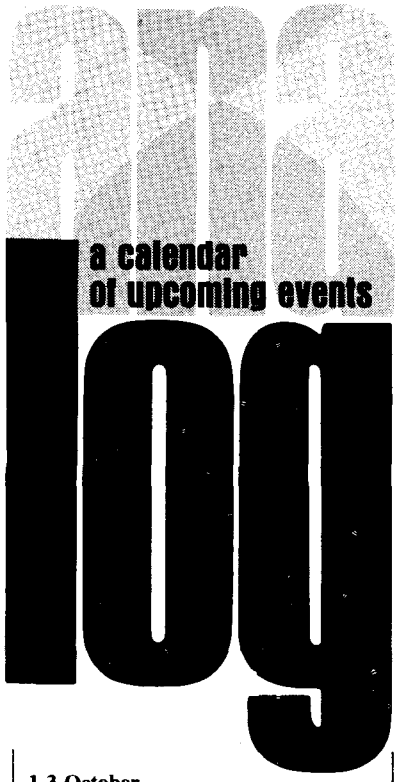

1-3 October
21st Annual IEEE Symposium on the Foundations of Computer Science at Lake Placid, N.Y. Info: Prof. Ronald V. Book, Dept. of Mathematics and Computer Science, University of California, Santa Barbara CA 93106. 805-961-2778/2171.

6-7 October
Fifth Conference on Local Computer Networks at Minneapolis, Minn. Info: Dr. Abe Franck, UCC, University of Minnesota, 227 Experimental Engineering, 208 Union Street, SE, Minneapolis, MN 55455.

10-12 October
NONCON 3 (Alberta SF conference) at Edmonton Inn, Edmonton, Alta. Guest of Honor—Vonda McIntyre, Fan Guest of Honor—Jim Young. Art show, films, readings, etc. Registration—$10 until 31 August, $12 thereafter. Info: NonCon, P.O. Box 1740, Edmonton AB Canada T5J 2P1.

10-11 October
ROVACON 5 (Roanoke area SF conference) at Northside High School, Roanoke, Va. Guests of Honor—Frederik Pohl, Kelly Freas, Paul Dellinger. Panels, workshops, art, etc. Presentation of Edmund Hamilton-Leigh Brackett Memorial Scholarship for Creative Writing, the Frank Kelly Freas Art Scholarship, and the Elizabeth Taylor Warner Dramatic Arts Scholarship. Registration $2 until 30 September, $4 thereafter. Info: RoVaCon, P.O. Box 117, Salem VA 24153. 703-389-9400.

11-12 October
OCTOCON III (SF conference) at El Rancho Tropicana Hotel, Santa Rosa, Cal. Guest of Honor—Theodore Sturgeon, Artist Guest of Honor—Don Dixon. Registration—in advance $8 (1 day), $12 (2 days) at door $9 (1 day), $14 (2 days). Info: Spellbinders, Box 1824, Santa Rosa CA 95402.

2-7 September 1981
DENVENTION II (39th World Science Fiction Convention) at Denver Hilton, Denver, Colorado. Guests of Honor—C. L. Moore and Clifford Simak, Fan Guest of Honor—Rusty Hevelin, Toastmaster—Edward Bryant. Registration—$25 until 1 September 1980. This is the SF universe's annual get-together. Professionals and readers from all over the world will be in attendance. Talks, panels, films, fancy dress competition, the works. Join now and get to nominate and vote for the Hugo awards and the John W. Campbell Award for Best New Writer. Info: Denvention II, P.O. Box 11545, Denver, CO 80211. 303-433-9774.

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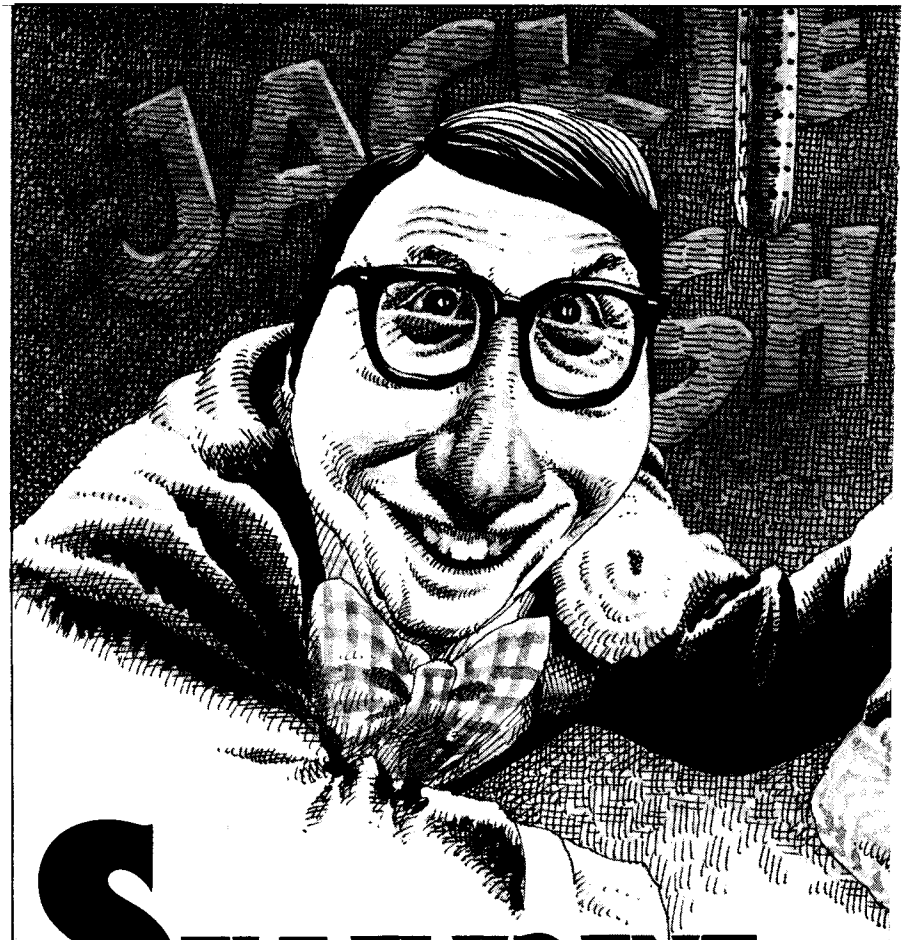

SELF-EVIDENT TRUTHS

CHARLES ARENT

The key to good research, as we all know, is asking the right questions.

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Richard Anderson

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Roger Herbert straightened his tie and smiled at himself in the mirror, hesitating so as to be just a little late, so as not to seem too eager. Downstairs, in the hotel lobby, the camera crews and reporters would be on the edges of their seats. He was elated, but had forced himself to appear calm . . . professorial . . . scientific. He gave himself a wink and, whistling "La Marseillaise" cheerily, put on his suit coat. This was it. His hour had come.

In the hall, his two graduate assistants were nervously waiting. Phillip was crushing his umpteenth half-finished cigarette in the already overflowing ash tray by the elevator. Maryanne was staring into the hall mirror, repeatedly running her hand over her head to force order on non-existent stray hairs. They turned to look at him, their faces going suddenly pale. He smiled. "Be calm," his eyes said. "*I* will take care of everything."

They rode down in the elevator without a word. He continued to smile calmly, occasionally catching their eyes, and projecting a fatherly affection when he did. Fame would be a mixed blessing. They would have a lot of adjusting to do. The flak they'd get from jealous colleagues would only be part of it. This discovery would arouse a good deal more than mere scientific ire. The social—the philosophical—import was enormous. It was that—and only that, he told himself—that justified his committing the professional sin of going straight to the press, of bypassing the journals.

The elevator doors slid open, and they were greeted by exploding flash bulbs and excited voices. Herbert led the way to the dais, politely waving off the shouted questions. And smiling, always smiling. They took their places. Intentionally, he took a longer than necessary amount of time to pour himself a glass of water. Then he leaned forward, hands folded in front of him, and waited.

The room grew silent. Only the whirring of the TV cameras and the continued popping of flashbulbs broke the silence. He surveyed the expectant faces.

"Ladies and gentlemen," he began. "As you know, I've called you all together here today to announce a discovery which is of the greatest importance for our American way of life." He paused. "For the first time in history, the principles upon which our Republic was founded have been scientifically validated. What I will offer you today is scientific proof that, to paraphrase Jefferson, all men—and women—are created equal."

Elsa Danby turned from the six o'clock news to her after-dinner coffee. Freddie had made a mess again. She sighed as she got up to wipe the ice cream from his shirt. Fred Senior peered over the top of his paper, then, taking another sip of coffee, returned to the sports page.

"You mustn't do that. Naughty. No no no." As usual, she'd adopted her baby voice for dealing with her sixteen-year-old son. Freddie simply grinned and, with a hiss and a sputter, pounded on the table. His father reached automatically for the coffee cup.

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"Elsa? Can't you make him stop that? He's going to spill the coffee."

"I'm trying, Fred. Can't you see I'm trying?"

She distracted the boy with a windup duck. A few twists of the key and the metal bird was whirring and clanking, waddling in midair. She handed it to Freddie. He stared at the toy with mild amazement. She sat, took another sip of her coffee.

"Fred?"

"Uh huh?" He didn't look up from the paper.

"Were you listening to the news just now?"

"Uh huh."

"Did you hear what that professor fellow said?"

"About what?"

"About everybody being smart."

"Uh huh. What about it?"

She knew he hadn't listened. "He said he'd developed a new IQ test. The first really scientific one."

"Uh huh." He spread the paper out in front of him, turned the page, and refolded it.

"He said that when you eliminate all the usual prejudices . . . . Well, that then it turns out that everyone has the same intelligence."

Fred let the paper drop slightly. "Another crackpot looking to sell a book." He again lifted his coffee cup.

"Well, not *exactly* the same. But close to the same. He said it means that everyone is smart."

"Elsa. How could everyone be smart? That's not what smart means." She had his full attention now.

She shrugged. "I don't know what smart means. But he's a scientist."

"A shrink."

"No. A scientist. He works in a lab . . . at Harvard."

Fred shook his head and returned to his paper. "I don't believe it."

They sat in silence for several minutes. Only the duck made noise. Finally, timidly, she tried again. "Wouldn't it be nice if they could prove that?"

"What?"

"That everyone was smart." He ignored her. "I mean I've always thought that. That everyone was smart in their own way. All these teachers and psychologists—"

He suddenly understood. He set the paper aside. "Elsa. I know what you're thinking. But it can't be. We have to face up to that." His voice was kind. Her eyes dropped, then turned ever so slightly toward her son. Freddie was making airplane noises as he brought the waddling duck first this way and then that way in the air.

"There is no way," her husband said, "that Freddie's going to be smart—or even normal. His brain is damaged. He's retarded."

Her eyes were suddenly fierce. "Don't say that in front of him. You'll hurt his feelings."

Fred sighed in exasperation. "He doesn't understand what we're saying Elsa."

"He does so understand." Anger now. "If it hadn't been for all those big shot teachers and psychologists he wouldn't be the way he is. *They* ruined

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him, ruined his chances for life."

Fred shook his head. "Elsa. I didn't really hear the news. But let's face facts. There's no way any IQ test is going to make Freddie smart."

Freddie gasped suddenly. He was sitting there, eyes wide with fear, the now motionless duck still in his hand.

"Duckie dead, Mommy. Duckie dead." He flinched a little as she reached for the toy.

She took the duck from him. "No, dear. Duckie's not dead. We only have to rewind him. See?" She turned the key with exaggerated movements. The boy's face brightened. "See how smart Freddie is? He knows that when something's wrong he should come to Mommy." The boy ignored her. His eager eyes were on the duck. "See?" she said, casting an angry glance at her husband. "I told you Freddie was smart."

The duck's feet began to move again. Freddie grabbed it. The airplane noises resumed.

"Oh, what a smart boy you are. Oh, what a smart boy."

He looked out over the studio audience, being careful to make eye contact here and there. That was important. His speech, delivered in a conversational tone, was perfected now. His previous TV appearances had enabled him to memorize it to the point where it seemed to be spontaneous. Some said he'd missed his vocation, that he should have gone into politics. Increasingly, that idea appealed to him.

But, here and now, he had to do his best for the *Tonight* show. It gave him by far the largest audience he'd had to date—and the guest host, Jackie Storm, was doing beautifully. Storm, an unknown stand-up comedian who'd just begun to do the night club circuit in Las Vegas, had no doubt realized that he, too, had something to gain from such cooperation. Reflected glory. Popularity by association. Yes, Storm was doing just fine. Having Janice Kelly on just before had been his idea, and he'd described her song, 'Equality,' as "the latest smash hit." A bit of hyperbole there. Or prophecy. In any case, Storm was softening them up. They were ready.

"From the beginning of human history," Herbert was saying, "some men have sought to set themselves up as the superiors of their fellow men." Storm nodded with appropriate gravity. "The Pharoahs and the Roman emperors claimed divinity. . . ."

"By which you mean they claimed to be gods, don't you?"

"Uh, yes. Yes. That's what I mean." Herbert got the message. He had to be careful about how he put things. "And, later, the kings of Europe claimed to rule by divine right—by the will of God."

Storm shook his head in mock disbelief. "But that all changed with the American Revolution, didn't it?"

Herbert smiled. The question was premature. "Well . . . yes. Yes. Our revolution threw out the kings . . . *and* the aristocracy. You see, for centuries the aristocrats had managed to convince the masses of mankind that they—the

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nobles, I mean—were superior to everyone else. By birth!" He felt a hint of discomfort in the comedian's face.

"I guess you could say that the majority of mankind were born losers." Storm punctuated this with one of his "funny" faces. The engineer turned on the canned laughter. Only then did muffled laghter begin to ripple through the studio audience.

Herbert smiled. "Yes. In a way. But the aristocrats were the ones who lost in the end. The Declaration of Independence proclaimed the equality of man. It was a revolutionary idea."

Storm looked thoughtful. "That was in 1776, right?"

Herbert didn't understand. The comedian's eyes moved ever so slightly in the direction of the audience. The psychologist went on, annoyed that his presentation was not being allowed to go smoothly—the way he'd planned. "Uh, yes. Over two cnturies ago." He paused. Storm—that damned fool—had broken his chain of thought. Then he saw it. Continuity. Continuity above all. "But that's the point. The equality of man was proclaimed over two centuries ago. And yet ancient superstitions lingered—but in new form. Men continued to feel superior to women, for instance."

"*I* never felt that way. At least not in front of my wife." Another face, more canned laughter. Again the audience took its cue.

Herbert feigned a gentle laugh, then went on. "The white race continued to feel superior to the colored races. The rich continued to feel superior to the poor. From birth! But it was no longer a vague sense of general superiority. A new myth surfaced—the myth that, if given freedom, men would sort themselves out according to their abilities. The capable would rise, the incapable would not. The divisions in society would thus be due to natural differences in ability. So, you see, divine intervention was eliminated from the picture, but the superiority of some was still regarded as being inborn. The same old prejudice, but dressed in new—and *pseudo*-scientific clothing. As usual, it was just another way of justifying prejudice, of rationalizing the built-in inequalities of our society."

Storm looked like he was about to interrupt. Herbert hurried on. "And, in our time, this ability difference became an even narrower concept. Intelligence became the magic word. The intelligent rose. The unintelligent lagged behind. And systems were designed to prove this. IQ tests were developed, and every child in our society had his or her IQ measured at an early age. And the future education of each child came to depend on his or her scores on these tests. A child who did well was often given special treatment. (But, of course, more often than not these were children who already had had privileged backgrounds.) A child who did poorly was subjected to lesser expectations in school, was given 'remedial' treatment or some such thing. And, of course, these children—more often than not—came from *under*-privileged backgrounds to begin with. As a result, the IQ tests ended up measuring differences in privileges that

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already existed and, by calling them intelligence differences, both justified and perpetuated those inequalities." He took a breath.

Storm turned to the camera and made his well-rehearsed idiot face. The audience laughed before the engineer could get the canned laughter going. Herbert swallowed his irritation. He mustn't alienate the audience. Comic relief. That's what it was that Storm was providing.

The psychologist smiled stupidly and continued. "And so it came to be believed that the rich were rich and the poor were poor because of differences in intelligence. (The Founding Fathers, forgetting their own declaration of 1776, said as much in *The Federalist Papers*—long before IQ tests had been invented.) And the same applied to differences between the races, *and* between the sexes. No God was needed. In born superiority could survive without divine sanction. It had 'science' to support it."

Storm seemed to have sensed his guest's irritation. He remained serious. "Would you explain what you mean there, Dr. Herbert?"

"I should have phrased that differently. No *true* science could have supported such a hypoth—such an idea. But a pseudo-science could. The use of science—or, rather, the *mis*use of science—to rationalize the advantages of the few is one of the great stains on the record of science itself."

"Could you explain what you mean by a *mis*use of science?" Storm remained serious. "I'm not a scientist myself—and when I hear that sort of thing I tend to think of pollution . . . or nuclear weapons."

"Ah. But those are mis*applications* of science. I am talking about something much more profound. I am talking about a misuse of scientific *method* designed to preserve ancient—*and* un-American—superstitions. I am talking about IQ tests."

Storm nodded slowly. Herbert's stare kept him in line. "I see. Well, we're all familiar with those. But maybe you could explain it a little. I'm no expert you see, and—"

"The explanation is quite simple, Mr. Storm."

"Jackie."

"Uh. Yes. Jackie. I myself fell upon it one day, when I was reading the Declaration of Independence." Herbert adopted his well-practiced far-seeing expression. "Thomas Jefferson, and the other Founding Fathers, had said it all. 'All men are created equal.' That is a profound truth that, until now, was never really recognized."

"Let's see. How does it go? 'We hold these truths to be self-evident.' . . ."

"Yes. That's it. But let me explain. You see, until now everyone mouthed those words without really believing them. And that was because the weight of the so-called scientific evidence said otherwise." Storm nodded, but remained silent. "I reasoned like this. If all men are created equal—and I believe they are—then something other than inborn intelligence created the differences between them. From there, the conclusion was obvious. Privilege bred more

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privilege. And the hand-maidens of the most ancient of superstitions were ready and waiting to prove scientifically that privilege and intelligence were one and the same—though they claimed only to prove that the former flowed from the latter."

Storm shook his head. "I don't understand."

"I'll explain. Here. Consider this. Here we have a society in which the rich unquestionably have more privileges, more advantages, than the poor. Not more rights, at least not on paper. But, in economic terms, more advantages." He signalled to Storm not to interrupt. "The same applies to the races. Whites are, on the average, more economically advantaged than blacks, or Hispanics, or other racial groups. *And* the same applies to the sexes. Men have more advantages."

He could see another wife joke forming on Storm's lips. He hurried on, to cut it off.

"Now, how do you go about 'proving' that this is the result of intelligence differences? That's quite simple. You make up a test, and call it an intelligence test. And you collect questions for your test, but you select them very carefully. You make sure that you have questions that, more often than not, will be answered correctly by relatively wealthy white males, but incorrectly by other groups. Then, to 'prove' that you've measured intelligence, you take the results of your test and compare them to the actual wealth and status of people in your society. And, of course, you find that wealthy white males—the very people you designed your test to favor—are almost always at the top in our society. Do you see how circular that is?"

Storm had been fidgeting. "I think I see what you mean. You collect questions that only the top people in society can answer, and then ask those questions of everybody."

"Well . . .'only' is too strong. It would have been too obvious. 'By and large' or 'on the average' would be better. One of the favorite arguments of the old IQ test designers was that the underprivileged sometimes did well on their tests, and the privileged sometimes did poorly. But the overall pattern remained intact."

"Yes, of course." Storm, for some reason, seemed hurried. "And then, by declaring that these questions measure intelligence, you 'prove' that the top people in society are more intelligent."

"Precisely. Now, what I—"

"I'm sorry, Dr. Herbert. But we have to pause for a moment for the sponsors. We'll get back to all of this." He turned to the camera with the light. "Stay tuned, ladies and gentlemen, for more about this revolutionary discovery. But now we want to tell you about *another* revolutionary discovery. The all new and improved Puritex. . . ."

Peter Dortman sat silently in his armchair, staring without seeing the commercial. His wife, Melissa, noticed that the stem of his unlit pipe was, again, clamped tightly between his teeth. But she said nothing. She didn't want to get him started again. In fact, after a mo-

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ment's reflection, she got up and turned the TV off.

"It's late, Peter. We ought to get to bed."

He grunted. "I don't feel like sleeping."

"But you have to get *some* sleep. Peter, you can't let this upset you so. You haven't slept normally for a week. It's bad for you. You know what the doctor said . . . ."

"Damn the doctor." He put the pipe down and turned again to the nearly bursting manila envelope on his side table.

She sighed and sat down. "Peter. There's no point in going over it all again right now."

He pulled a wad of newspaper clippings from the folder and began leafing through them, sneering all the while. "It's a disgrace, Melissa. It's criminal." He stared down at each clipping before tossing it aside.

"Everyone Is Smart" said the *Post*.

"Eggheads Cracked By Brain Drain" roared the *Daily News*.

And, at the bottom of page one, the *Times* noted that "*Harvard Psychologist Claims Equality of Intelligence*."

Predictably, the last one bothered him most. He set the folder on the floor, stood up, and began pacing. "I think I'll go for a walk."

"Not again. It's past midnight. Last night you were out till three."

"I'll be back soon. I—I just can't sleep." He headed for the coat closet.

She just sighed again. It was pointless.

"I ought to go to the media now—like he did—before he goes any further. He's got the whole damned country in an uproar with his—his stupidity." He put on his coat. The angry muttering was familiar—too familiar.

She made the usual reply. "But you said that that was unprofessional. That you had to go through the journals first—and then to the press. Your paper will be in print next week. What's the hurry?"

"He's got the whole damned country in an uproar. *That's* the hurry! He's twisted everything around. Told them what they want to hear. And they love it! In their monumental stupidity they love it!" She looked away, biting her lip. When he snarled at her like that, she felt like saying what she really thought. It wasn't her fault. He shouldn't snarl at *her*. But—no. No reason to cause more upset.

"And he talks about method." The angry mutter was followed by the sound of the door opening. He closed it behind him with just a bit too much force.

She sat silently for several minutes, staring. Her wifely duties notwithstanding, Peter was beginning to irritate her. Not because he was upset. No, that was understandable. But she wished he could at least be honest with himself about what it was that really bothered him.

Her eyes fell on the clipping from the *Times*, lying on the floor. *That* was the real problem. It wasn't really the different conclusions they'd reached. It was the fact that both Herbert and Peter had used the same method—and that Herbert, by rushing to the press, had won all the credit for that method. And

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yet Peter kept insisting that Herbert's method was "inane." She wished he could be more honest. The fact was that Herbert had beaten him to the punch, and that—not their opposite conclusions—was what was bothering him.

Glancing again at the *Times* clipping, she found herself thinking that even their apparently opposite conclusions were not all that different.

She sat for a few moments more before getting up to turn the TV on. The set blinked and buzzed for several seconds before clearing. (Peter hadn't really fixed it.) The audience was laughing again. Jackie Storm had no doubt told anther joke. She liked Jackie Storm, despite what Peter said. "Mindlessness," he called it. But mindlessness was good sometimes. It helped you to forget your problems.

"Well," Roger Herbert was saying, "I can't reveal any of my questions just yet. It would invalidate the test if people knew the questions beforehand. But, with time, I'll be able to develop alternative questions—and then sample questions can be made public."

"I see," said Storm. "Now, about the method you used to select the questions . . ."

"Quite simple once you've analyzed the problem. The point was that existing IQ tests purposely discriminated between social, ethnic, and sexual groups."

Storm's eyebrows raised at the word "sexual." "Please, Dr. Herbert. The sponsors." The canned laughter began. Melissa Dortman smiled.

Herbert didn't even do that. Peter was right about that. There was nothing funny about that man. He had no sense of humor.

"So what I did," Herbert continued, "was to first generate a list of over a thousand questions. I then gave this original 'test' to representative samples of the population and analyzed the results." Storm was being serious again. That, Melissa thought, was too bad. Herbert went on. "I compared the answers of the two sexes—uh—of men and women. Any question that one sex answered correctly more often than the other sex was eliminated. That question measured the sexual difference—*not* intelligence. Do you see what I mean?"

Storm nodded eagerly. "I know a few questions like that." More laughter.

Herbert looked drawn, genuinely annoyed. "In any case, Mr. Storm, I did the same for ethnic and racial groups. Then for geographic groups. And then for socioeconomic groups. Any question that whites answered correctly more often than, say, blacks actually measured racial differences—*not* intelligence. Questions that New Yorkers answered better than the people in Des Moines measured geographc location—*not* intelligence. And questions that the poor could not answer as often as the rich, or even the middle class, measured social class—*not* intelligence. And I proceeded like that, eliminating any question that discriminated against any group of people in our society. Of course, refinement will be necessary. I may have missed some parameters, some group differences. I considered sexual orientation. And

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membership versus non-membership in clubs. But there are no doubt other group differences that I haven't yet covered. That's why I got some scores lower than 100. Those less-than-hundreds no doubt have some characteristic, or set of characteristics—other than intelligence of course—that set them apart. That's my next task. Perfection doesn't come easily. For all I know the under-hundreds are all vegetarians . . . or bowlers. And we wouldn't want to discriminate against bowlers, would we?"

"Certainly not," said Storm jeeringly. "Adidas is one of our sponsors." More laughter. But, this time, even the canned stuff seemed subdued.

"But you do see what I mean? I mean I've nothing against bowlers."

"Yes. Yes, I see."

"Good. Well, the test that I ended up with was then given to a random sample of the population. And that was successful beyond my wildest expectations."

"You mean almost everybody got 100."

"Yes. And the lowest score was a 95%!"

Storm hesitated for a moment. "So, in effect, your test asks questions that almost everyone can answer."

"Exactly! By eliminating biases due to racial, sexual, and socioeconomic discrimination—and other types of discrimination as well—I have proven that the intelligence of *all* people is roughly equal."

Storm hesitated again, looked confused. But the doubt on his face gave way to an enthusiastic smile. "That's marvelous, Dr. Herbert! Absolutely marvelous!" He turned to the camera with the light. "What do you say folks? Doesn't that deserve a hand? What d'ya say?" Storm began clapping. The audience joined him. Canned laughter rose momentarily, but disappeared when the engineer realized his error. Herbert bowed his head with practiced humility.

"And now," Storm said, his voice raised above the level of the clapping, "now we have something else marvelous to show you. The new Ford Gila Monster, the car that made prehistory. . . ."

Peter Dortman glared at the window on the opposite side of his office.

"Calm down, Professor Dortman." said the policeman. "You're not in any danger."

"*I am calm!*" Dortman shouted. Sergeant Puffer gave him a knowing look, but said nothing.

"Death to Dort. Death to Dort." the voices outside chanted in unison—slowly, monotonously, stupidly.

"They'll get tired of it soon and go back to their dorms," the Sergeant said. "And we've got the building surrounded. There's no danger."

"It's not 'danger' that bothers me!" Dortman pounded his fist on the desk. "It's the sheer stupidity of it all!" He got up abruptly and began pacing near the desk, at a safe distance from the window. "I should be happy! That's what I *should* be! They're just proving my point! *That's* all they're doing!"

Puffer offered him a cigarette. He

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waved it away with a snappish gesture.

"You know why they're really doing it, don't you?" He didn't wait for the cop to answer. "It's because I've seen the truth—and they hate the truth. That's why. It insults them. They're all so used to being pampered, to being told how smart they are. I'm one of the few left who dares to flunk them. *That's* why they hate me!"

Puffer shrugged in agreement. That was the professional thing to do. "The best thing to do, Dr. Dortman, is to stay calm."

"*Calm*!? How can I stay calm with this—this rabble—out there chanting like a bunch of idiots!?" He groped in his shirt pocket for his pills. "Idiots," he muttered.

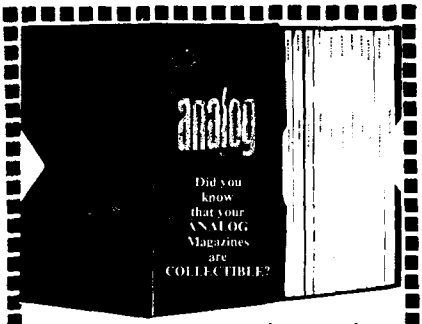
There was suddenly a loud crash. Dortman stood, his hand still over his pocket, staring at the brick and the shards of glass on the carpet. The blood rose in his face. He turned and ran for the broken window.

"IDIOTS!" he screamed at the sea of faces in the quad. "*You are all idiots*! And nothing you do can change that! *I* have proven it!"

The crowd roared. Oaktag signs moved up and down above the faces. Down With Racism. Down With Sexism. The signs were everywhere. "Death to Dort," they chanted. "Death to Dort."

His eyes fell on one sign. Sergeant Puffer was trying to pull him away from the window. He broke away from the policeman's grip.

"Do you see that!?" he screamed. "Do you see what I mean!? They've



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misspelled it. MISSPELLED IT.''

And suddenly all was darkness.

Elsa Danby shook her head sadly as she poured one capful of Puritex down the detergent chute of her machine. It was too bad about that Professor Dortson. And can you imagine those college students, saying things like that to a *professor*! The younger generation was going crazy. Other people's children. And they didn't even feel guilty about giving the poor man a heart attack. She shook her head again, closed the lid on the machine.

She didn't really understand it all. Especially what they said on the Fred Wellenby show about how it was ironical that Dortson and Dr. Herbert had used the same method, and had actually agreed that all people had the same intelligence. And yet they were enemies. And that because, by doing exactly the same thing, they'd come up with different questions. It didn't made sense. That professor on the Wellenby show said that only their assumptions had been different. She guessed that must have been what it was. Fred Wellenby seemed to agree that that was true. But she still couldn't see what all the fuss had been about.

She pressed the ''On'' button, waited for the sound of rushing water, and then turned to go upstairs. Freddie was being too quiet. She'd better check.

It didn't seem to make much difference whether you asked questions that everyone could answer or asked ones that nobody could answer. It still showed everyone was the same. And, besides, Fred Senior hadn't been able to answer her when she told him what Dortson had said. All he'd said was ''It's Dort*man*.'' And then he'd turned away.

But it was true. What she'd said made sense. Okay. She admitted that Freddie would never be smart. But, if everyone was dumb, like Dorfman had said, then Freddie wasn't any dumber than the rest.

She paused at the kitchen table, shook her head again at the headline on the *Daily News*.

''Dummymaker Dead'' it said.

She went to look for Freddie. ■

● Energy will remain in some sense the lord and giver of life, a reality transcending our mathematical descriptions. Its nature lies at the heart of the mystery of our existence as animate beings in an inanimate universe.

Freeman J. Dyson

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JERRY POURNELLE

THE ETHICS OF RHETORIC

THE ALTERNATE VIEW

Time was when philosophy was a noble calling. In the early days of man's intellectual development, there were teacchers who prided themselves in their ability to "make the worse appear the better cause." They called themselves sophists, and they would, for a fee, teach you to win arguments without regard to the merits of your case.

Socrates set his face against this sophistry. Reason, he argued, should be the servant of truth, and the skills of rhetoric should not be prostituted for deception. He called this philosophy, and his pupil Plato founded a school—the Academy, taking its name from the groves of Academe where it was located—which was so successful that "academics" have paid lip-service to the philosophic ideal ever since.

Of course the sophists soon

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adopted the language and style of the Academy and called themselves philosophers. They've been at it ever since.

The sophists developed a panoply of tricks and rhetorical devices to deceive their audiences. For example: It seems reasonable on the face of it to give equal times to opposing sides in a debate. Skilled sophists can take great advantage of this seemingly fair device. One of the sophist's most potent weapons is the half-truth: a statement true by itself, but false in context. The best answer to the half-truth is the whole truth (as much as is known, anyway), but the half-truth told in a single paragraph often requires many pages to refute.

Case in point: a guest editorial in the May Analog by John Ahrens, Assistant Professor of Philosophy at Bowling Green State University. Mr. Ahrens has the title of "philosopher"; but his article is pure sophistry, dedicated to persuasion rather than enlightenment. Ahrens is a master of half-truths. His article is shot through with them, and I haven't the space to answer them all. I'll simply have to take on a representative sample.

Item: he says "the few utility companies that have invested in conservation have found it to be profitable.

"Two Washington utilities have undertaken to finance the conservation efforts of their customers by offering *no-interest* loans, with no payments due for a period of *ten years*. They have found that this program results in substantial increases in profits by allowing them to avoid the massive expenditures to expand generating capacity. Clearly, it is cheaper to save electricity than to generate it." (Emphasis in original.)

Now that's fairly amazing. When annual inflation is 10% and above, money loaned at no interest for ten years is money simply given away. How can that be profitable? In some confusion I called the Washington Water Power Company of Spokane and talked to Jan Wendle, their Marketing and Controls Engineer; and as I suspected, the whole truth leads to somewhat different conclusions.

The first cut leaves Ahrens' half-truth intact. Washington Water Power (WWP) sells electricity for 1.5 cents per kilowatt hour. They sell all they have. Since it costs them at least 4 cents per kw/hr to get more electricity—whether from outside vendors or through constructing new generating capacity—they lose money every time they make additional sales. Thus they have a powerful incentive to conserve. It makes economic sense to subsidize rate-payers' conservation efforts.

But why are their rates so low? Only in the Northwest can you buy juice for 15 mills (1.5 cents/kw-hr). Everywhere else

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the price runs from 5 cents (50 mills) to 15 cents (150 mills), and in a few unfortunate places the rates soar higher. Why can't WWP simply increase rates to cover generating costs?

The answer is simple. As a regulated utility, WWP's prices are set by law, and, as Ahrens states in another half-truth, "the price is simply whatever is necessary to cover the utility's operating expenses, tax liability, and a guaranteed profit." WWP's operating expenses are fairly low, because in the Pacific Northwest most of the power is hydro-electric, and hydro plants have no fuel costs. When you average in the operating costs of their thermal plants you still get a very low figure. They can't raise prices because they're not allowed to. Thus "conservation" remains attractive because of the artificial price structure.

Well, so what? They're still making a profit, aren't they?

We're not through. Once you've paid for the dams and generators, hydro-electric power is cheap, but it's *not* reliable. It varies directly with weather, to wit, how much rain and snow falls in a given year. Demand for electric power, on the other hand, is much more constant. Thus if you're to supply your customers in years of little rainfall, you'll have "surplus" kilowatts in years of heavy snow and rain. The Pacific Northwest power companies have cooperated since the forties in making 10-year forecasts of power demand. (It takes about ten years to plan and construct and get on-line a big power plant.) Their design criterion was to meet base demand requirement in years of low water.

At first that was simple. When demand grew, they went out and built new dams. Now true; in order to meet years of bad water, they had to have more capacity than was needed in years of good water. It's no good being able to supply needs merely *on average;* they had to plan for the worst case, or else have insufficient power in the worst years. A really bad years comes about once each thirty years, for twenty-nine years out of thirty they had "surplus" capacity; the water was simply let spill over the dams.

Eventually, though, they ran out of dam sites. There are simply no economical places to put new dams in the Northwest. (Actually that's not strictly true, but there are severe environmental costs to damming up the Snake River Gorge and other scenic attractions.) The answer was to build thermal plants, and WWP and other Northwestern companies built them. In good years the thermal plants were used at considerably less than capacity. (This includes the nuclear plant at Centralia, which has a low ratio of power delivered to generation capability because in years of good water its power wasn't

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much needed.) In bad water years the thermal plants went on-line.

But then came the environmental crunch, and they weren't allowed to build new thermal plants. They went through their spinning reserve. Every year needed better water conditions. Now all reserves are gone. It used to be that they'd be down to bare bones once each thirty years; now fifteen years out of thirty they're in trouble, and there's no room for growth at all.

So they've turned to subsidizing conservation; but they're not happy with it. As Jan Wendle put it, "If you could conserve yourself to prosperity, Bangladesh would be the wealthiest nation on Earth."

But there's more to the story yet. Remember those "surplus" capacities? They weren't wasted. They built a huge DC tie line between Grand Coulee Dam and Southern California, and sold those kilowatts down here. There was still cheap juice left over, and it attracted aluminum companies.

To make aluminum you need electricity. Indeed, the price of aluminum is driven by the price of juice; the ore is plentiful. Thus aluminum companies went to the Northwest. Sure, they knew that some years there wouldn't by any "surplus" electricity and they'd have to arrange for other employment of their labor force, but that could be factored in as a cost of doing business, and it was still profitable to go where the juice was cheap twenty-five years out of thirty.

They went there in a big way: in Spokane alone, 26,000 jobs are dependent on Kaiser. Spokane has a total population of 300,000. The city's economic life is tied to aluminum. This is true of much of the Northwest.

And the Northwest's economy is doomed. You see, most of the hydropower comes from dams built by the U.S. Army Corps of Engineers. That's a public facility, and it was written into the law that publicly owned utilities get first call on that power. Aluminum companies, vital to the US economy, are not publicly-owned utilities; thus small municipal power companies can get juice when Kaiser cannot.

But Oregon has no publicly owned utilities—they're all privately owned—so Oregonians have to pay fuel costs for juice, and some Oregon power costs 50 mills, while right across the border Washingtonians are getting federally generated power at 15 mills. Oregonians saw no reason to put up with that when the solution was so simple: form a big state-owned public utility which buys power and sells it to private companies.

California is about to do the same thing. Why should Washington get all the benefits of Grand Coulee when taxpayers in all states paid for the dam?

This means that California and

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Oregon, as public utilities will get power before Western Power Water Power does; WWP cannot afford to build new plants because WWP hasn't the capacity and the Northwest's economy will be wrecked, while aluminum prices rise everywhere.

But how did they get in this miserable situation? Couldn't they see it coming?

Of course they could. They did. The Northwest power pool knew they needed more thermal plants, just as they now know that in 1983-84 they face *huge* power shortfalls and massive layoffs in the aluminum industry no matter how much their customers conserve energy.

They tried to build power plants. In particular, they tried to build nuclear power plants. They weren't allowed to. They were prevented by legal tricks. And now they're down to giving money away in a desperate attempt to "conserve."

Their own fault, Ahrens says. They should have known that nuclear plants were the wrong way to go. It isn't that they're unsafe. In his opening paragraphs Ahrens himself uses Three Mile Island as an illustration of just how safe nuclear plants are. Then follows another half-truth.

"The propaganda of the utility companies notwithstanding, nuclear power plants are among the most expensive methods we have for generating electricity," says Ahrens.

They sure are. But you know why. Because the anti-nuclear ideologues have manipulated the legal machinery to jack up the price of nuclear plants beyond reason.

As I write this, American engineering firms are installing American-designed nuclear power plants in Japan. They have not stinted on safety. The Japanese are, if anything, more radiation-conscious than we are (and with good reason). Furthermore, their whole nation is both densely populated and in a primary earthquake zone. Nuclear plants for Japan have to be carefully designed and carefully built; overdesigned and over-built for installation in the US.

But here's the hooker. It costs one third as much to build a nuclear plant in Japan as it does to construct *the exact same plant* in the United States. Why? Well, it's not cheap labor. Skilled labor isn't cheap in Japan, and furthermore the US firms have to pay extra to keep their American engineers working overseas.

But in Japan they can get the plant built and on-line in five years. In the US you can't get that same plant design on-line in much less than fifteen. The ten additional years are consumed in the permit process: hearing, trials, appeals, more hearings, more trials, more appeals; two thirds of the costs of a US nuclear plant goes to lawyers and the additional interest costs directly caused

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by legal delays. So the very people who have caused these cost escalations are now saying that nuclear plants aren't economical! this is the moral equivalent of breaking a working man's legs, then castigating him for being out of work.

We haven't even got started on Ahrens' article, but we're about out of column space. We haven't looked at his claim that "the government invested at least $9 billion in nuclear technology. Had these R&D costs been absorbed by the utilities, the cost of electricity generated by nuclear plants would be increased by 50%!" (True again but irrelevant: the money *has been spent*. Should we now throw away the results? Incidentally, an appreciable fraction of that went to the Manhattan Project.) We've not examined his odd use of "capital intensive" as a term of opprobrium and "labor intensive" as a term of praise, although it's not at all clear to me that there's virtue in human toil; I suppose the ultimate in labor-intensive power generation would be treadmills.

We've not room to examine his statement that " . . . conservation, wind energy, hydropower, biomass conversion, and so forth . . . pose none of the problems that so distress Pournelle," while failing to deal with what I had actually said, namely that "at the moment it takes from fifteen to thirty times as much energy to build a[n Earth-based] solar power system as the system annually can produce," although that remains true.

But no sophists, truth is less important than persuasion; as it was in ancient Athens, and is now in Bowling Green. . . . ■

● To be boosted by an illusion is not to live better than to live in harmony with the truth; it is not nearly so safe, not nearly so sweet, and not nearly so fruitful. These refusals to part with a decayed illusion are really an infection to the mind. Believe, certainly; we cannot help believing; but believe rationally, holding what seems certain for certain, what seems probable, for probable, what seems desirable for desirable, and what seems false for false.

George Santayana

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THE REFERENCE LIBRARY

by Tom Easton

Timescape, Gregory Benford, Simon & Schuster, $11.95, 391 pp.
Thrice Upon a Time, James P. Hogan, Ballantine, $2.25, 311 pp.
Songs from the Stars, Norman Spinrad, Simon & Schuster, $11.95, 274 pp.
The Terra Data, E. C. Tubb, DAW, $1.75, 172 pp.
Aldair, Across the Misty Sea, Neal Barrett, Jr., DAW, $1.75, 188 pp.
The Magazine of Fantasy & Science Fiction: A 30 Year Retrospective, Edward L. Ferman, ed., Doubleday, $10.00, 310 pp.
Chrysalis 7, Roy Torgeson, ed., Zebra, $1.95, 287 pp.
Timetipping, Jack Dann, Doubleday, $8.95, 236 pp.
Takeoff!, Randall Garrett, Donning, $4.95, 254 pp.
San Diego Lightfoot Sue and Other Stories, Tom Reamy, EarthLight, $14.95 (slipcased, $25.00), 238 pp.
The Cybernetic Imagination in Science Fiction, Patricia S. Warrick, MIT Press, $15.00, 282 pp.
Your Next Fifty Years, Robert W. Prehoda, Ace, $5.95, 348 pp.

In March I took a weekend trip to New York to visit my in-laws. In the process, I gained the opening lines for this column, for I found the visit acutely, physically uncomfortable. I live in Maine, you know. I heat mainly with a woodstove, which keeps one room toasty warm and the rest of the house tolerable. I have an oil furnace too, with the thermostat set at 58°F to maintain a reasonable minimum temperature when the wood fire goes out at night or when it simply can't keep up with the weather. The result—for an entire Maine winter, I'll go through seven or eight cords of wood and 100 gallons of oil (or less). Others do as well, too, which is why Maine has the best record in the country for reducing oil consumption in these days of crisis. And we *don't* freeze up here. It is possible to be quite comfortable at 60-65°. A sweater helps. So does letting yourself get used to it.

I won't rave about the aesthetics of wood heat. They exist, both pro and con. I will say that a lower living temperature is possible, comfortable, and an entirely reasonable way of saving gobs of oil. And now back to New York—I wasn't visiting the freezing poor. My wife's family is comfortably well-off. They live in tastefully furnished apartments, dwelling places I found stifling because they were heated to what seemed 80-90°. They probably weren't quite that warm, but remember that I'm used to 60-65°. Those apartments *were* heated much more than is strictly necessary. They, and the thousands of others like them, offer an immense opportunity for conservation, and an opportunity that would not mean sacrifice, at that.

Now, how does all this make a lead for a book review column? Simply, the

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kind of consumption exemplified by those New York apartments contributes to and aggravates the world's current and future problems of resource shortages, shortages that need not be as severe as they are and will be. And a great many current SF novels are set in a future of scarcity that might have been avoided or at least put off by more rational consumption patterns. Greg Benford's **Timescape** (there's a pun in there) is an example. The context includes resource shortages. It also includes overpopulation and ecodisaster. By 1998, the chemicals we have put on the land—pesticides, herbicides, fertilizers, etc.—have washed into the sea, there to begin a self-sustaining process that promises to end human life. The world is run by a World Council which, among other things, controls the trickle of funding for scientific research. In England's Cavendish Laboratory, a young researcher, John Renfrew, is working with tachyons. He has the idea that they can be used to communicate back across the years, to send a message that will prevent disaster. To do so, he has to focus a tachyon beam on suitable experiments, involving super-cooled indium antimonide, in which the beam can influence the noise level. Fortunately, such experiments were being done in the early 1960s by a California physicist, Gordon Bernstein.

When Renfrew tries his message sending, Bernstein notices the Morse code in the noise. He deciphers it, experiences suitable amazement, and then tries to convince others. No way. He is clearly seeing things in his data. However, he eventually prevails, and steps are taken to prevent disaster.

The story is told in alternate episodes, first 1998, then 1962-63. It develops in terms of professional and personal rivalries and alliances, affairs and infidelities. There are vast stretches of physics, intended to display the difference between past and future, the doing of physics and the nature of physicists, and to show off Benford's familiarity with the recent past of his own discipline, but also to analyze the problem of time-travel paradoxes (as convincingly as any other SF writer) and demonstrate that time must branch into alternate histories.

One does care about Benford's characters, about their problems and fates. *Timescape* is a disaster novel, after all, and it shares a certain grippingness with the rest of the genre. It is well enough written, too. But for all that it fails to hold the attention as well as it might. I believe this is because Benford has spent so much time on his characters, on developing the lives and thoughts and feelings affected by his plot that the plot itself loses momentum. The story would have more impact if it were trimmed by a quarter or a third, and Benford's people would still be alive enough. But don't let my grumblings stop you from reading the book. When you consider that well-developed characters often leave readers wishing a story didn't end so soon, Benford may well please more people than not. If so—well, I still think he overdid it. I praise him more for his idea of the history-message time loop, and I wonder if such a thing could possibly help us out of our resource-shortage bind.

James Hogan, by chance, has tackled a theme very similar to Benford's. In **Thrice Upon a Time**, he posits a classical lone (but not mad) scientist who has discovered a new form of energy that is generated by subatomic events

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and leaves the present for the past. At first, he can communicate with himself over a span of minutes. Improvements in his apparatus extend that to a couple of hours. A message from the future reveals how to piggyback messages for longer jumps. Then, with the aid of a genius grandson and his buddy, he finds that messages can change the present. Together, they begin to see time as a sheaf of presents; time is a river, the present a boat in the stream, and there are many boats: if the people on one boat act in such a way as to change the river (pulling a stick out of the water, say), the river will be different when other boats come by.

Hogan's concept is one of serial universes, not parallel ones, and I have seen it only once before, in Sal Snatsky's "Time Cycle," a short story that appeared here in June 1973. It's an intriguing concept, but it is also a confusing one, and Hogan spends so much time on developing it that his story loses momentum. His characters, on the other hand, could have used more attention, while the plot itself is adequate. A new fusion reactor goes haywire, threatening to destroy the Earth, and a novel plague appears, threatening to destroy humanity. The answers, of course, lie with cross-time communication, for even if one of the boats on the river of time must sink, the others can be saved.

You can count on Norman Spinrad for pleasurable reading. Sometimes you even get more, in the way of philosophical or human insights. **Songs from the Stars** is an enjoyable post-holocaust tale, starring the land of Aquaria, nee California, which pursues the virtuous life of dependence on wind, sun, and muscle. It eschews technology, though it must have solar cells, wind turbines, and the like to make its lifestyle possible. The technical goodies come from the far side of the eastern mountains, where they are manufactured by remnants of the technologists who destroyed the world. The trader-immediaries are the "mountain william" tribes, an aggravating cuteness even if they do live in mountains instead of hills.

Aquaria, of course, is caught in a bind. To exist, it must embrace hypocrisy, for without the imported gadgets, its way of life would degenerate to the too-traditional nasty, brutish, and short. A few people, such as Clear Blue Lou, Perfect Master of the Clear Blue Way, recognize the problem. When the black technologists engineer a confrontation of virtue with hypocrisy, Lou and Sunshine Sue, head of the Word of Mouth communications net and possessed of her own technological visions, face the problem with a trip to the technologists' base and thence to a long-abandoned space station. The station had been built to listen to messages from other stars, and on it are answers.

I enjoyed *Songs*, and I believe it should be read widely. Spinrad has split human life into technophilia and technophobia, and effectively dramatized the necessity of reconciling the two if anyone is to have a life of freedom and comfort. Technology must and can be used in such a way that human life is enhanced and the world is not destroyed. It should not be abandoned, for that way lies barbarism. The message may be simple, but it *is* important. Consider the econut protestor, screaming slogans as he wields a sledgehammer with one hand and holds a transistor radio to his ear with the other. Even he must agree that some uses of technology

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are consistent with his ideals.

I am sure you are familiar with E. C. Tubb's Dumarest of Terra series, now in its twenty-second installment. It's space opera, starring a redoubtable competent hero who, though born on Earth, has travelled so far that now no one knows of his home. The series is the tale of Dumarest's effort to go home, of his continuing battle with the Cyclan, that organization of ambitious, emotionless, human computers, of his gathering of clues. He confronts villains of every stripe and defeats them all. But can he find Terra? Never. Even when he has the coordinates in his grasp, fate conspires to deprive him.

The Terra Data fits the mold. The title suggests that he finally finds his home address, and that is nearly so. The story shows more of the Cyclan than most as it flicks from the world of Elysius to Cyclan HQ and the Cyclan's dreams of galactic domination. On Elysius, Dumarest seeks a man reported to know Terra's coordinates. But the man is dead, the coordinates engraved on a medallion he wore around his neck, and the medallion is buried with him. To get them, Dumarest must dig a mine in tricky ground, find the treasure the dead man sought, and then find the man himself. There are the obligatory woman, alien creatures (unintelligent, but nonetheless a threat), and strange conditions.

Fun stuff. But I have two objections. The more important one is that in Dumarest's cosmos cavemen steer starships by slamming buttons with stone axes. Worlds are linked by the high technology of ftl ships, but the technologists are rarely to be seen. The worlds are populated by merchants and criminals and politicians whose education goes no further than how to cobble together an outhouse. Governments are feudal, autocratic, and venal. Human ideals are vanished as if they'd never been. Or does Dumarest never look above the seamy side of life? Tubb says he does, but even then he doesn't see much to bless our descendants for. I can accept that the majority of humanity will always be, as they are and have been, muttonheads, but where are the minority? Where are those who make us proud to belong to their species? Their presence would let me think Tubb more realistic.

The second objection is that the Dumarest series is too blamed long. When it was new, I looked forward to six or eight more books before a final answer. Now that it is stretching toward two dozen, I am getting impatient. Come on, Tubb! Give the man a break!

Neal Barrett, Jr., is the author of a series of intriguing paperbacks from DAW. They all concern one Aldair, apparently a Gaul of the first few centuries A.D. He fights barbarians and faces the forces of a Roman sort of civilization, including an anachronistically inquisitorial religion. But the first book of the series soon reveals that all is not what it seems. The barbarians and other strangers are indeed strange beasts, for Aldair's world is a far future Earth abandoned by humanity and left to humanity's creations, several species of animals given more or less human form and intelligence and doomed by mysterious machines to repeat after a fashion the history of humanity. Aldair's ancestors were pigs. His neighbor species are transmogrified lizards, wolves, and bears. And there are others, too.

So far, so good, you say. Barrett has a nice science-fictional justification for stories of primitive adventure. He does,

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too, and he handles this level of his yarns well enough. But Aldair's story is more than mere adventure. The driving force behind his journeyings is the search for answers to mystery. He wants to know why humanity created his and the other kinds, why they disappeared, why they set up the machines to rule history, and more. He is spurred by strange visitors and events. And as he seeks his answers, he becomes friends with members of other species, forms a company of aliens whose mutual bonds make the antagonisms of race for race and species for species seem a fevered dream. Not that all is blissful cooperation. Far from it. But the frictions become more personal than general, as in truth we wish they were with us.

The series began, as I recall, with *Aldair in Albion*, in which Aldair accepted his mission and found the machines that control history. **Aldair, Across the Misty Sea** is, I believe, the third volume. In it, Aldair voyages across the Atlantic to the Americas to find horrors, marvels, an explanation, and a seminal clue to humanity's disappearance. He confronts disaster, doom, and mutiny, and he rises above them all to face what may be a final answer. That answer will not, however, emerge until the next volume. I'm looking forward to it.

A few months ago, I reviewed the 30th anniversary issue of F&SF and said that Ed Ferman should get it out as a book. Well, he's done it, adding two introductions, one by himself and one by Asimov, and dropping out the magazine features. The title: **The Magazine of Fantasy and Science Fiction: A 30-Year Retrosective**, and the same high praise applies. You can get it from the Science Fiction Book Club.

Chrysalis 7 is out now, with stories by Ed Bryant, Tom Monteleone, Orson Scott Card, Michael Bishop, and assorted others. Roy Torgeson, the editor, has written me that *in general* the first and last stories in a Chrysalis are his own personal favorites. He gets specific in his letter, but he also expresses a reluctance to let me make free with his own opinions; he doesn't wish to offend, he says, and I can tell you that a writer's ego is a tender thing (though it is also necessarily extremely resilient). I will say that we don't always agree completely, though we do both find good stories in the books (*he* had better). I expect you will too, though you may agree with neither of us.

For C7, my personal favorite, neither first nor last, is Monteleone's "Sonata for Three Electrodes," in which a biochemist volunteer is given the talent of a dead musician thanks to experimental techniques of recording and transferring cerebral patterns before death. But that isn't all he is given. Another goody (first in the book) is Leanne Frahm's "Deus Ex Corporis," in which a nun conceives as a result of cancer treatments; will her child be a child of God? Different groups prefer different answers, and Frahm doesn't give away too much.

I seem to like Jack Dann better as an anthologist than as a writer. As the one, he picks stories I enjoy. As the other, I find him depressing, unsatisfying, and

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sometimes confusing. His collection, **Timetipping**, proves my point, at least to me. For example, take the long "Junction" that concludes the book. Junction is a small town in the midst of chaos, where form emerges under the prod of dreams and wishes, where demons live. Junction itself is Heaven, despite squalor and whoring and bigotry. But a demon arrives to lead hero Ned to a reality resembling ours, though subject to chaotic flux. There the people dream of Junction, dream Ned's dreams, and they want an end to it. The answer? The universe has personified itself. Solipsism is real and true. And Ned, one ineffectual, fairly slimy human being, is the end-all and be-all.

Timetipping is not all like "Junction," although the story is fairly representative. The title story, a tale of involuntary, spontaneous time travel, verges on satisfaction. "Camps," a tale of experiential overlap between a modern hospital patient and a World War II concentration camp victim, is the best in the book. "Camps" is so good, in fact, that I can forgive the book its other sins. It makes the book worth reading.

Two more that deserve comment: One is Randall Garrett's **Takeoff!**, a collection of parodies, pastiches, reviews in verse, and groaners guaranteed to rouse at least a grin. Don't miss it. The second is the one and only collection of Tom Reamy's short fiction anyone will ever publish: **San Diego Lightfoot Sue and Other Stories**. And that's a shame. Tom was a beautiful writer. You've heard that before, many times, perhaps so many times that you're feeling skeptical. Don't. The Nebula he won for the title story was thoroughly deserved. And that story was no fluke. Get the book and see. Check out "Twilla," "Dinosaurs," "The Sweetwater Factor," "The Detweiler Boy," and all the rest, even if you remember them well. Read 'em, and weep for the death of a talent. Tom Reamy, 1935-1977.

Patricia Warrick has done what many folks (me? I dunno) will call a signal service to the SF field. She has taken a couple of hundred SF stories dealing with robots and computers, described them on punch cards, classified them with the aid of a computer, and written **The Cybernetic Imagination in Science Fiction**. Her framework, she says, is systems theory, and she finds three broad categories into which her stories fit easily: isolated systems, mostly short stories in which the author explores a single facet of one idea; closed systems, where stories stick to Earth and tend to be dystopian; and open systems, where stories take the cosmos for a stage and explore the benefits we can gain by associating with our intelligent machines. The last category is the most recent and, says Warrick, contains the most creative stories: "If the literary imagination conceives of itself as locked in a deterministic, closed system, it seems to create destructive images, using a conflict mode. In contrast, if the imagination assumes an open-system model, it penetrates the wall of the system, questing and seeking beyond. This avenue of transcendence yields creative images of the future" (p. 165).

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Warrick pays attention to history and discusses the parallel developments of computer science and cybernetic SF (which, she says, has lagged behind the science). She discusses the nature of consciousness as an either/or matter: the humanist and free will vs. the mechanist and rigid determinism. She does not seem aware that a mechanist need not be a determinist if s/he allows for stochastic mechanisms such as underlie the function of the nervous system, although she does approach the idea later in the book. This apparent ignorance may color her judgment of stories unduly, but it is other ignorances that make her suspect to the SF reader: she does *not* know the people who wrote the stories—she lists Kuttner and Padgett together at one point, although Padgett was Kuttner plus C. L. Moore; and she refers to Eando Binder as "he" when "Eando" stood for a "they," *E*arl *and O*tto. I'm quibbling, but I'm irritated, and the book's wealth of typos doesn't help. Does the book have any value? Of course it does, for it puts one variety of SF in its intellectual context. It could have ranged more broadly, however (the non-novels studied were chosen from anthologies, and heavy stress is laid on Asimov and Dick), and it could have been more carefully done. Perhaps it shoud have been done by a computer scientist instead of an English prof. All too often, it seems that the useful insights into SF do not come from those whose primary orientation is literary. Scientists and SF writers approach the necessary syncretic capability much more closely. But that's a tune you've heard before.

Cancer
dies with the patient
Heart Disease
dies with the patient
Huntington's Disease
kills on and on and on.

NATIONAL HUNTINGTON'S DISEASE ASSOCIATION

Suite 501, 1441 Broadway
New York, N.Y. 10018
212-966-4320

79-3

THIS SPACE CONTRIBUTED BY THE PUBLISHER

In **Your Next Fifty Years**, Bob Prehoda has painted a highly optimistic picture of extended life, urban redesign, artificial intelligence, space industrialization, and contact with an alien world. He says the favorite dreams of SF will become real, and he says it very readably, using the scenario—you are there!—approach.

But—I don't believe it. Prehoda's future is a fairly standard high-technology picture, though with a few idiosyncratic touches. Like other such pictures, it requires both great trust in technology and science and a sudden commitment of the world's populace to rationality, along the lines of: " . . . scientific rationalism is indispensable if a society is to remain free. Like the arts and lit-

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erature, science dignifies the human spirit. Scientific inquiy—the scientific method—is the ultimate expression of free will, of human freedom, for science allows us to gain control over nature. If nature . . . cannot be controlled, then man is not truly free'' (pp. 53-54). I cannot argue, but neither can I believe that people will set aside their infamous perversity in favor of sweet reason, no matter how necessary such a change may be.

A second problem is that the timing of Prehoda's scenario is questionable. He has it that rationality triumphs when the species gets a Malthusian boot in the tail in 1994, not so much because of population pressure as because a combination of industrial particulates in the air and a sudden flareup of volcanic activity cools the world and reduces agricultural productivity (he neglects CO_2-induced warming). All right. A hard enough boot just might bring us to our senses, but when will it come? It might come this soon. It might hold off for decades. It will, of course, come sooner or later, especially if we let our numbers continue to increase. Eventually, we are bound to suffer some kind of agricultural disaster and the ensuing famine. Nevertheless, Prehoda's fifty years may well turn out to be a century, or even two.

Optimism is lovely stuff, and it's nice when one gets a chance to see its roots. Prehoda seems to be something of an SF fan. He refers to Heinlein as the greatest current SF predictor, and in his epilogue to chapter 11, he describes the 2033 Presidential inauguration, whose attendees include Nobel laureates Asimov, Heinlein, Hoyle, Niven, Pournelle, and Clarke. (He also promotes Solzhenitsyn to President of the Union of Eurasian Democratic Republics and Jim Baen to Media Czar.) It's a good wish, as my mother used to say, but it'll be a cold day in Tophus when the Stockholm rate SF that highly. ■

● I do not know what I may appear to the world; but to myself I seem to have been only like a boy playing on the sea-shore, and diverting myself in now and then finding a smoother pebble or a prettier shell than ordinary, while the great ocean of truth lay all undiscovered before me.

Isaac Newton

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BRASS TACKS

Dear Stan:

The rest of the truth. . . .

The central point of my editorial in the May Analog was that government has mismanaged the energy industry. After sifting through the insults and accusations that make up the bulk of Pournelle's response ("The Alternate View," this issue), I was able to identify two objections to my view. Neither is adequate to undercut my arguments.

First, Pournelle claims that a nuclear plant can be built in Japan in one-third of the time and for one-third of the cost that is required to build the same plant in the U.S. The reason, he thinks, is obvious: "the anti-nuclear ideologues have manipulated the legal machinery to jack up the price of nuclear plants beyond reason."

But Pournelle fails to tell us why Japan is rapidly backing out of its commitment to nuclear energy. In 1970, the Japanese AEC was predicting that it would be deriving 60,000 MW from nuclear plants by 1985. By 1975 this had dropped to 49,000 MW; by 1976, it had dropped to 23,000 MW. This is odd behavior for a country that views nuclear energy as safe and economical.

A similar situation exists in the U.S. and Western Europe, and the most common explanation is increased capital costs combined with increased opposition to nuclear plants. And there can be no doubt that the opposition has increased capital costs. But what about the subsidies that are not included in capital cost figures?

In the U.S., the government continues to fund most R&D on nuclear technology. The Price-Anderson Act drastically reduces the insurance costs of nuclear plants. The government also pays the bulk of waste-disposal costs.

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If unnecessary safety regulations were removed, nuclear energy might be cheaper. If subsidies were removed at the same time, it might well become more expensive.

The utilities saw this over thirty years ago and refused to develop nuclear energy without massive aid from the government. The fault lies with the government for encouraging the development of nuclear energy in spite of opposition by the utilities and the insurance companies.

Second, Pournelle objects to my claim that conservation is profitable for those utilities that have invested in it. This is true, he claims, only because the government has imposed an artificial price structure and restricted the construction of thermal plants. One result of this has been to threaten the existence of industries that depend on electricity.

Now, there can be no doubt that government has created an artificial price structure in the utilities industry; sometimes prices are less than they would be in an open market, sometimes they are more. But the fact remains that the cost of conserving a kilowatt-hour of electricity is less than half that of producing it. Conservation is certainly cost-effective for the consumer.

But what about the company? If Washington Water Power (WWP), for example, built more thermal plants and raised its prices, wouldn't its profits increase? Indeed they would, *if* WWP could be guaranteed of selling the additional power at the higher price. Fortunately for WWP and other utilities, but not so fortunately for consumers of electricity, the government provides such a guarantee.

A host of building codes require that certain kinds of energy technology be used in most buildings with little regard for any energy saving design features the buildings have. Other regulations severely restrict the use of renewable resource energy technologies. Still others create natural gas shortages and raise the price of other fuels. These regulations, rather than increased demand or efficiency, make generation of electricity seem cost-effective.

If these regulations were removed, builders and home-owners would no longer be faced with such great disincentives to the use of conservation and renewable resource technologies. And this would free-up vast amounts of generating capacity to supply industries which need electric power.

It would also free-up capital for other things, like colonizing and industrializing space and the moon. If we don't do this soon, we may not be able to do it at all; the U.S. government and other U.N. members are doing their best to erect obstacles in our path.

Contrary to what Pournelle seems to think, use of ever greater amounts of energy is not intrinsically good. What is good is what we can accomplish with the energy we produce. The current regulatory structure encourages waste and thus prevents us from accomplishing a great many things.

And we cannot solve this problem simply by changing the regulatory scheme or replacing current regulators with new ones. The last 2000 years have demonstrated that it is foolish to erect political and economic systems that depend on the intelligence and good-will of the leaders. The way to solve this problem, as I indicated in my editorial, is to replace regulation with an open market in energy technology; this would allow all options to be tested.

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It is doubtful that an open market would mean a return to the treadmill; this is an inefficient use of labor. Nor would it be likely to result in the construction of large solar electric plants; these are an inefficient use of capital. But it is also doubtful that it would result in the construction of more nuclear plants; they are only slightly more efficient than treadmills and solar electric plants, and they are not the only alternative.

Choices among technological options should be made on technical and economic grounds. When government makes these choices, it is on political grounds. The nuclear industry is but one example of this. The space program is another; we invested a fortune in beating the Russians to the moon but we are investing almost nothing to industrialize space. The military is another; we can annihilate the human race but we cannot defend U.S. territory against conventional or nuclear attack.

It is imperative that we get control of technology back into the private sector. Until this is done, we can only hope that government does nothing worse than sabotage the energy industry.

JOHN AHRENS
Department of Philosophy
Bowling Green State University
Bowling Green, OH 43403

Dear Mr. Pournelle,

I read your column and shed tears of blood ("The Alternate View," June 1980). It must be apparent to anyone of vision that you and other advocates of space are right in everything you say. Where, then, is the heart of America? In God's name, who is running your great country—a band of fools, or a band of thieves?

Jane Fonda chanting slogans against nuclear power—government financed commercials preaching the gospel of conservation—the President announcing calmly that it is time for Americans to reduce their expectations—new industry hobbled by bureaucratic regulations and conservationist paranoia—NASA announcing, regretfully, that it must abandon its hope of touching Halley's comet due to lack of funds.

I cry for America because space is not only the future of your nation, but the future of mankind. You had it in the palm of your hand. And you let it slip away. The world is on the brink of a dark age. America can still leap to the stars, before she falls into the chasm of shadows, but she has no time left for doubt or indecision, no time for weakness.

The time has come for those who understand these things to *act*, not talk, not bemoan the short-sightedness of politicians. I see people like Carl Sagan selling their books on the tube, but I don't see anything happening. I don't see anyone doing anything. Space needs *passion*, not words. If only those people who protested against the Vietnam war, against the seal hunt, against nuclear power, would protest *for* something.

Surely science fact and science fiction people could be organized into one cohesive body with the sole purpose of getting the American space program back on the tracks? Instead of talking, the leaders in space speculation could put pencils to paper and come up with the hard numbers to sway that most immovable of objects, the Washington politician.

There are plenty of science fiction

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conventions, but I have yet to see a demonstration or a protest march in favor of space exploration. The papers are full of news about the deaths of baby seals, but print not a word about the death of the human race. If a petition were circulated via the science fiction magazines and sent to Carter with enough names on it, maybe he would take time out from worrying about his political future and consider the future of NASA.

You had it and you lost it. NASA may never again be what it was during Apollo. But if people learn that they can get their energy from the sun safely via space mirrors and end their need for conservation and their dependence on foreign oil, if the bureaucrats discover that space is the logical dump for radioactive waste and the place for nuclear power; if private industry recognizes the virgin resources waiting to be exploited with no native population to nationalize plants or conservation groups to picket them—surely they will crawl from their fetal positions and raise their eyes from their navels to the stars.

The sheep must look up now. Tomorrow is too late.

DONALD TYSON
138 Coronation Ave.
Halifax, W.S. Canada

Dear Mr. Schmidt,

I take issue with the myth that Jerry Pournelle perpetuates in the April issue—that of the hedonistic businessmen who is interested only in instant profits. The large, complex corporations have pioneered the efforts which result in progress and higher, long run profits. I am referring, of course, to the development of corporate planning capabilities. The success of such companies as Bell, IBM, Exxon, etc. is based on their propensity to look beyond their noses. In the complex environment of business, planning is a necessity, not a luxury. Unfortunately, heavy taxation and economic regulation force cut backs in planning expenditures, and enforce short term thinking instead.

If we reject this myth as an explanation for the lack of corporate involvement in space, we must look for other reasons. I suggest that the primary reason is that NASA has established a legal monopoly that prevents even any consideration of independent action. NASA has refused on at least one occassion, and probably more, to allow a company to purchase an already built, but mothballed Saturn V.

A secondary reason for the lack of corporate activity stems from the usurpation by government of research funding. We have, as a society, come to wait for government grants, etc. to decide which areas to exploit. Those companies with ideas which have tried to deal with NASA have met with political, as opposed to economic, roadblocks. (The satirical story in the April issue about the development of fire is only too true.) No one wants to commit his own money, if he can get government funds. It then becomes the taxpayer who absorbs the risk.

And finally, there is the Moon Treaty recently ratified by the Senate. No company can even try to develop the moon except under U.N. supervision, and then whatever profits are generated are to go to those most in need—the Third World—not to those who did the work and took the risks. No one would be foolish enough to invest billions of dollars and years of work if they can't get anything out of it.

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In conclusion, let me emphasize that I have enjoyed the exchange between Pournelle and Stine, but Pournelle overlooks the reality that it is government—which he advocates as the only possible developer—which is, in fact, the major roadblock to creative progress.

DAVE WEEKS

8360 Spring Valley
Dallas, TX 75240

Dear Mr. Schmidt:

In the June, 1980, "Brass Tacks" you printed two letters requesting financial aid from the readers to continue the exploration of Mars. Both Mr. Anderson and Mr. Twarog need to get together and pool their appeals if they really want a concerted effort and successful results.

Regardless of the need for such funding in their minds, I have a question. Why? What benefit is there for the American public, businesses, or charitable groups to "invest in exploration?" I know of the spinoffs possible. I am a believer in pure research. But, how many others have such a belief?

Government usually explores for gain in the immediate future. It is a fact of political life. Anyone who ignores this fact will face a funding problem if their research is a long-term low-payoff project. The trick is to keep a continuous, low level payoff coming in to point to each year. Robert Heinlein made a major point in how to fund space exploration in *The Man Who Sold The Moon*. The whole trip was sold, in both senses of the word, in terms of potential profit.

Consider, if you will, the theory that most of man's early exploration was in terms of rather immediate profit. New hunting grounds, new areas to cultizise, a new source of cheap labor, wealth, trade, etc. Prince Henry (the Navigator) of Portugal was not sending ships down the coast of Africa in search of knowledge. They were in search of markets, a safe route to India, and a way to bypass the Arabs (who were actually not Arabs) of the Middle East. The Queen of Spain did not finance a Genoese sailer to see if the world was round. She was after a route to India (the Portuguese had a lock on the trade by then). The question was not whether the world was round or flat. The question was how to get rich.

If space exploration is ever to get really off the ground for good, those who are its exponents should start looking for the profit potential of every step. And, I don't mean by dipping into the public purse. Sure, going into space is expensive but did you ever consider the cost (at the time) of outfitting sailing ships and sending them out? If the reward is greater than the cost, the enterprise will be funded. Perhaps a little lying would be in order for some projects?

People and governments invest in terms of some type of payoff. We have milked the national pride, remember space exploration was still science fiction until the Russians made the first successful launch. Now it is the time for the Madison Avenue types to come up with the economic advantages of space exploration. Perhaps there is petroleum locked in the moon's rocks, an abundance of titanium, or whatever. Who knows until we go there.

The best way to stimulate space exploration is to get off the non-national designation and stop hindering interested firms in exploring for potential

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profits (have you ever looked into the problems of an un-authorized space launch?). Granted, there will be problems. But, if space exploration is made profitable, it will happen.

For closing, consider the possible economic gain to one of the national TV networks for a close up view (exclusive) and actual sampling of Halley's Comet. And, consider the spin-offs beneficial to scientific space exploration at the same time.

C. HENRY DEPEW
3312 Lake Shore Dr.
Tallahassee, Fl. 32312

If you're going to sell anybody on anything, you have to speak to him in his own language.

Dear Dr. Schmidt:

Regarding the science fact article "Beyond First Contact" by M. David Stone in the June 1980 issue of Analog:

Perhaps one approach to doing something about funding the SETI would be to invoke the old devil of international competition, and pose the question of what the result might be if the Russians (or Chinese or ?????) were to successfully and privately make contact with ETI.

TENNY LODE
10187 East Weaver Place
Englewood, Co. 80111

Dear Dr. Schmidt

As a long-time reader of Analog, and one fascinated with the question of time and time-travel, I was very pleased with *most* of Donald Franson's "One Time In Alexandria." The idea of a time viewer and the possibility of viewing that which has already happened will, I believe, be resolved. However, I do take issue with his answer on how the library at Alexandria was destroyed. A viewer is a passive instrument. It does nothing but accept the information that is at that moment being focused on. This goes for our own eyes as well for any of the nightscopes used for surveillance. These nightscopes in particular only see by the infra-red that is *given* off by the object in it's sights and does not project a beam of infra-red that would (as in Mr. Franson's story) be projected from the viewer in question, bounce off the object in the manner of radar or sonar and then give the object to the viewer. As far as I have been able to ascertain this sort of viewer does not to my (albeit limited) knowledge exist at this time.

Granting that a viewer for seeing into the past could exist using the premise of the story, I feel that it is rather too much of a stretch of the imagination to believe that not only can one view backwards in time, but also project infra-red rays! (Even the inventor of the viewer in the story said that another modification would be necessary in order to physically contact the past.)

I have always enjoyed the caliber of stories that have been offered in Analog. However, the premise that the story's ending is based on is as ridiculous as "Superman" projecting various bands of the electromagnetic spectra with objects designed for recieving only (his eyes). Could you possibly explain how such a gross lapse of logic and common sense enabled such an ending to find it's way into an otherwise soundly-based publication?

HOWARD R. KATZ
1259 E. Wilson
Batavia, Il. 60510

Certainly: it's not a lapse. It's not quite right that "a viewer is a passive instrument"—consider the simplest of

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all cases, a window. Franson's viewer was like a window with one side in the past and one side in the future, and the key to the ending is that light can pass both *ways through a window*—and *that this viewer* did *project infrared from its own built-in source. See p. 116 of the story, where Fagerquist says, "There's even an infrared attachment so you can see inside unopened tombs." Present-day sniperscopes don't need lamps because they're intended mainly for seeing such things as living, warm-blooded organisms and operating engines. Such things tend to be in short supply in unopened tombs—or deserted libraries—so for those applications you* need *an artificial source.*

Dr. Dr. Schmidt,

Why do so many science fiction writers feature an Earth-type planet in their stories, then write about each such planet as if it had about as much land surface, and about as much climatic, cultural, topographical and ecological variety as Rhode Island? For instance, in Barry Longyear's story "Savage Planet" is a statement to the effect that winters are severe on Bendadn. One gets the impression that the whole planet has its winters simultaneously. Does it have an axis perpendicular to the plane of the ecliptic, but follow a cometary orbit? Then winter would be the time when the planet was furthest from the sun. Surely such a scheme would rate some comment.

Perhaps an Australian would be particularly well aware that winter comes at different times to different parts of the same planet. But surely any inhabitant of a country that includes Maine and Florida ought to know that winters can differ considerably on different parts of the same planet. For that matter, any citizen of a nation that includes the Navaho tribe, Amish people, black ghettoes and New York Jewry should know that one species can have several different cultures. But, to take another story, William Cochrane's "Class Six Climb," the natives of Kyle Murre have only one culture and only one native language. The planet in that story features forest, and only one kind of forest at that, as its sole type of vegetation. Surely, just as Earth has deserts, Arctic tundra, mountains, grasslands, savannah woodlands, tropical rain forests and coniferous forests, an Earth-type planet would have several types of vegetation.

This complaint is not directed specifically at Longyear or Cochrane. They are simply cited as examples of an all-too-common failing. I see it as a failing, anyway.

V.W. TERRILL

108/70 Bay Rd.
Victoria, 3191, Australia

I agree that the failing you mention is too common, and I'd like to see a lot more in-depth world-building in the manner of Poul Anderson or Hal Clement. But I'm not sure I agree with the examples you cite. Remember, a story may take place in one small region of a planet so that even if many other regions exist and the author knows all about them, the story may provide no occasion to mention them. And it's perfectly true that a planet with a large axial tilt would have severe winters over at least a large part of its surface—and that statement does not imply that those winters occur simultaneously everywhere.

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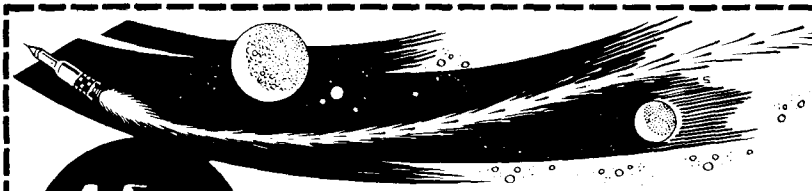

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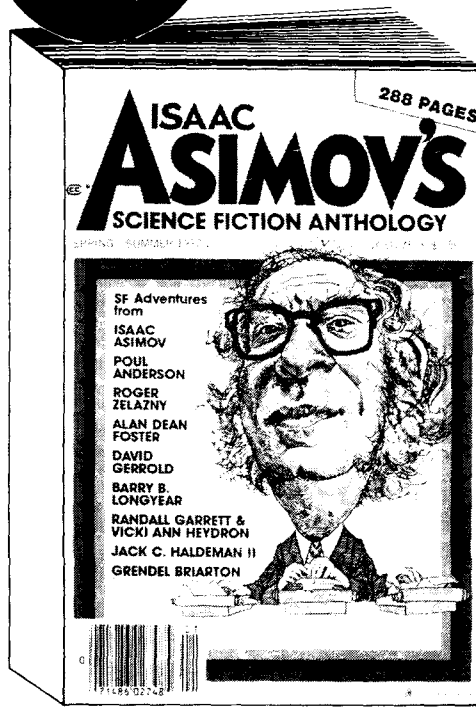

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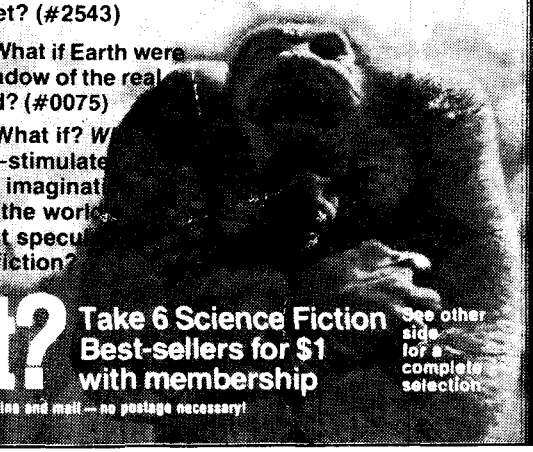

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